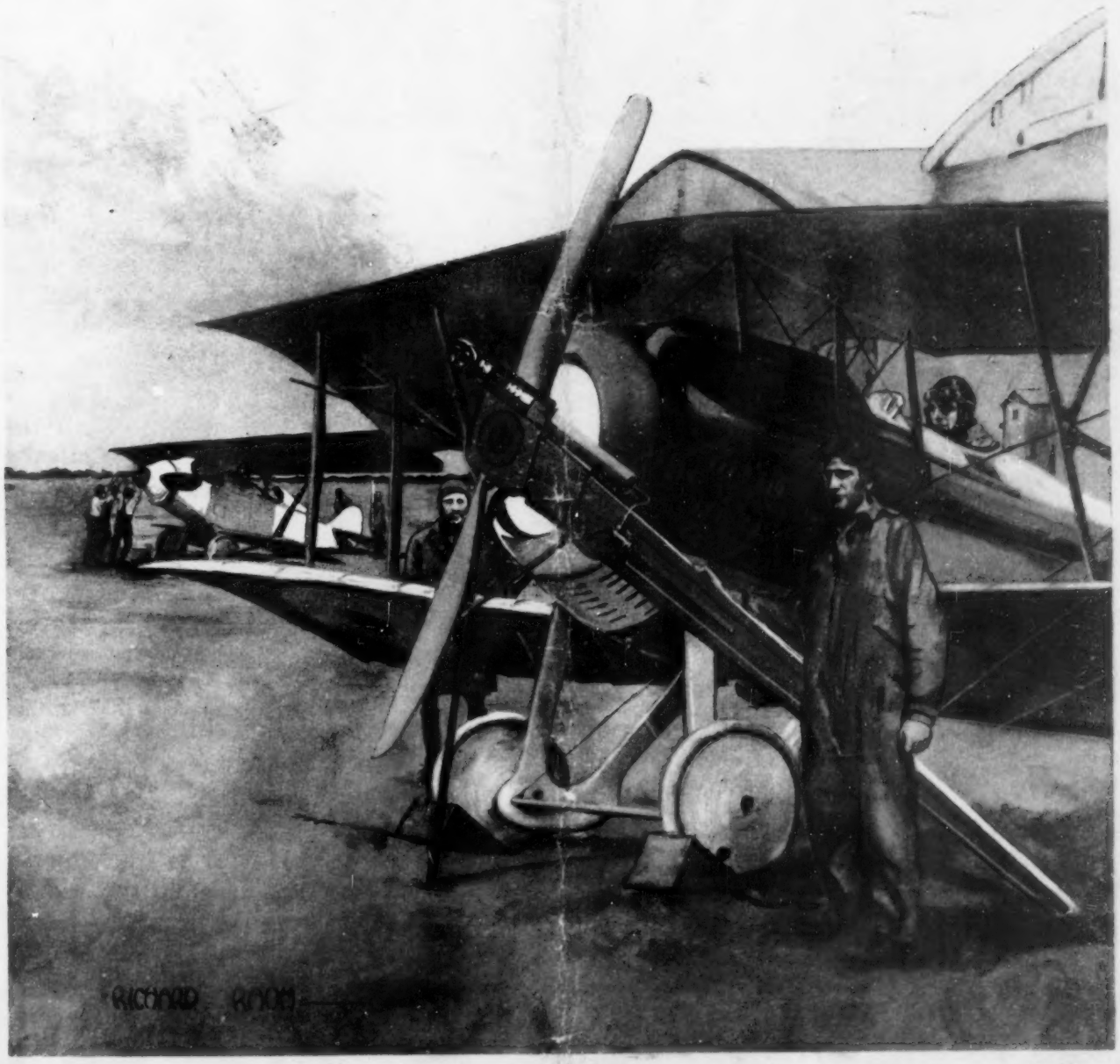
SCIENTIFIC AMERICAN

A Weekly Review of Progress in

INDUSTRY · SCIENCE · INVENTION · MECHANICS

IN THIS ISSUE:

And Other Features



CRANKING THE AIRPLANE PROPELLER WITH A FLASK OF AIR—[See page 425]

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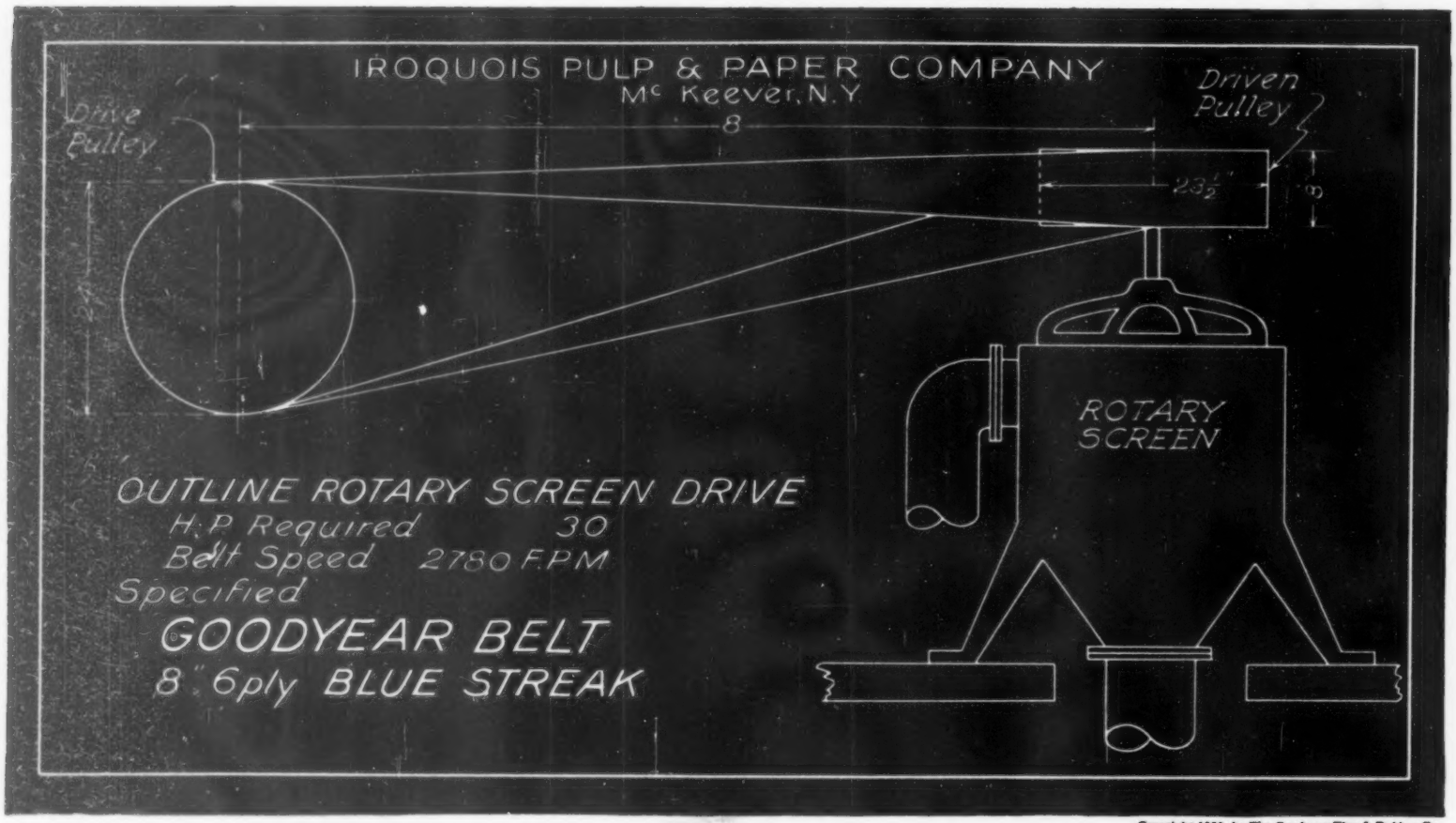

20% More Production—and the G. T. M.

A quarter turn on short centers, a heavy crown pulley, and the presence of considerable moisture where the belt had to work, kept the Iroquois Pulp & Paper Company, of McKeever, New York, buying a new belt every 30 days for their rotary screen drive. That was before the G. T. M.—Goodyear Technical Man—analyzed the drive to determine what belt would do the best work and last the longest time on it.

The G. T. M. based his recommendations not on the fact that he was a Goodyear man and had belts to sell, but on his practical knowledge of belting plus a careful study of every feature of each drive. He figured in all the factors that affected belt performance and life—30 horsepower to be transmitted, a drive from a 24-inch pulley on a line shaft to a 23½-inch pulley on the rotary screen, a quarter turn on short centers—only 8 feet—a speed of 2,780 feet per minute, and a heavy damp prevailing all the time.

An 8-inch, 6-ply Goodyear Blue Streak met the requirements. Its friction surface held the pulleys in a firm grip that prevented slippage and transmitted full power. Subjected to the heavy moisture, it did not stretch. To the severe strain imposed by the duty on the quarter turn it responded with inbuilt strength and flexibility.

Four months of Goodyear Blue Streak service—you will recall that previous belts wore out at the rate of one a month—not only cut belting cost by 50% but also established an operating record of 20% increase in production. The men and machines were going on with their work instead of waiting while the rotary screen had its belt taken up again.

A plant analysis which included a detailed study of every drive in the Iroquois plant was made at Supt. Archie Brown's suggestion, when the G. T. M. dropped in to see how the Goodyear Blue Streak was working. In line with the same scientific method of conserving and utilizing the full energy of the plant, the Company has installed Goodyear Hose and Goodyear Packing, confident of the same economical, long-lived service from them as from their Goodyear belt.

If you have a belt problem, involving either a single drive or an entire plant, there is something of value for you in the Goodyear analysis idea. The G. T. M.'s time and experience are at your command without charge. If he specifies a Goodyear product, you may rely on its ability to do more and better work, over a longer period of time, at lowest final cost.

THE GOODYEAR TIRE & RUBBER COMPANY
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GOODYEAR

SEVENTY-SIXTH YEAR

SCIENTIFIC AMERICAN

THE WEEKLY JOURNAL OF PRACTICAL INFORMATION

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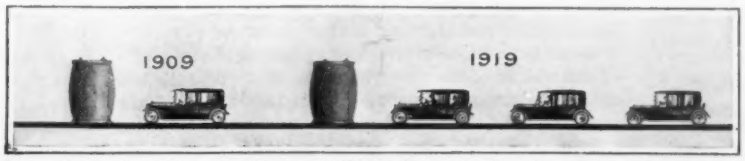
Why Is Gasoline High?

TEN years ago gasoline was cheap—those whose motoring experience dates back far enough will recall the day when it first went above the ten-cent mark. And we need not go back ten years to find a time when gasoline was good—when it vaporized easily and burnt with far less residue than it leaves today. In this day of high gasoline and gasoline which only by tolerance escapes the epithet "bad," it is distinctly worth while to inquire why price and quality have moved so rapidly in opposite directions, and whether the present conditions are to be permanent.

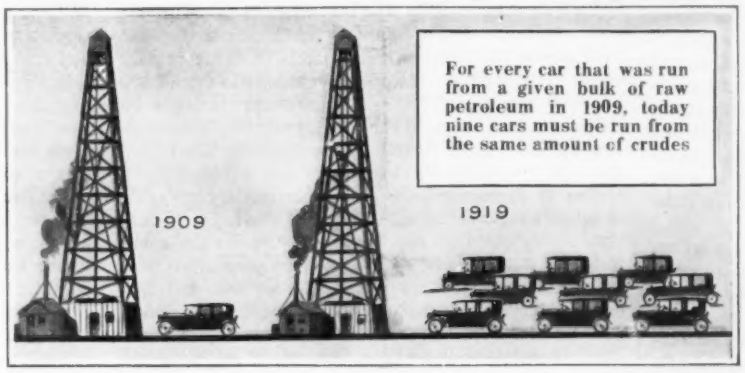
Gasoline, as we all know, is a product of petroleum. A good many of us, however, have probably not realized that gasoline is not the sole concern of the petroleum industry, or even its chief concern. Crude petroleum, in fact, is a thick oily liquid, of no definite composition at all. It is not even a single chemical compound, but a highly complex mixture of many compounds—mostly hydrocarbons, a few sulfides and oxides and nitrates. According to the part of the world in which it is found, and the circumstances of its origin and treatment, it varies widely in just what constituents are present and in just what proportions. But in any event, almost all of these constituents evaporate with more or less ease at ordinary atmospheric temperatures.

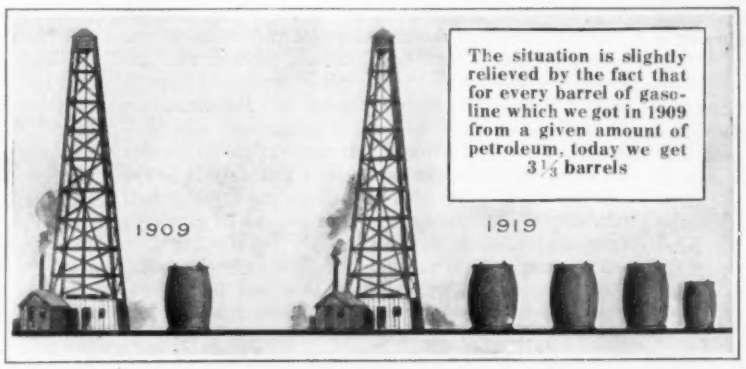
These various substances, however, all possess different evaporating points, so that if the crude petroleum is left open and free to behave according to its nature, its various "fractions," as they are called, will pass off into thin air, one after another. The process of "refining" of which we hear so much consists merely in controlled and accelerated fractional distillation, so that one after another of the constituents pass off, the lightest first followed by the others in order, to be collected at the other side of the apparatus. The first item to go over is the natural gas which is always present in some proportion; this is followed by the various liquid members of the alliance; and at length there is left only the solid residue of paraffin wax or asphalt, as the case may be.

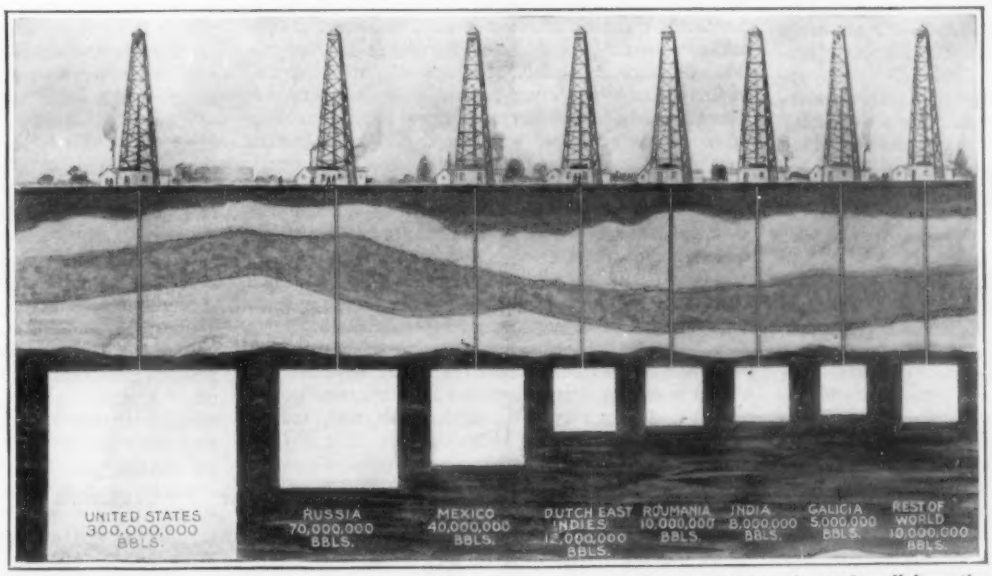
All the fractions are used for something. The gasoline with which we run our motor cars and airplanes is merely one of the fractions, with whose uses we are most familiar because they touch us most immediately. But of an importance little if any less is the fuel-oil fraction which will not volatilize readily enough to be used in the automotive engine, but which is burned in immense quantities under boilers of oil-fired locomotives and ships and stationary engines, and in internal combustion engines of the Diesel type. And even when we get down to the solid residues, there is a use for them.



The net result of the conditions exhibited below is that for every car run from one barrel of gasoline in 1909, three cars must be run from one barrel today







The world's output of petroleum in 1916. The white space represented as withdrawn by each well from the oil-bearing strata beneath indicates a cube of volume proportional to the amount of oil for which it stands

So when we talk of increasing the supply of gasoline without going entirely outside the petroleum industry in search of new sources, there are but three possibilities which we may have in mind. The direct and obvious thing is to seek new supplies of petroleum; to get more gasoline by getting more petroleum to make it from. To understand just what factors are here involved we must look for a moment into the circumstances under which petroleum comes into being and is exploited commercially.

Although classed as a mineral, petroleum is of organic origin. It represents the natural distillation products of plants and animals buried in the muds and oozes of geologic time. It is therefore of almost universal occurrence, but far from universal in commercial quantities. It is only available in these quantities where the rock formation is such that the petroleum from a comparatively large region has drained off into comparatively small pockets, there to be subsequently subjected to pressure of some sort so that when the pocket is tapped from above the oil will flow out.

At present the United States produces about two-thirds of the world's petroleum. Of the other third, by far the larger part is credited to Russia and Mexico. The prospect of new fields of importance being opened up gets always less. And the prospect of making old fields yield more is practically zero. For as just suggested, we must have pressure to make the oil flow; but by flowing it relieves the pressure—so the more we get out of a well, the harder it is to get what is left in it. The remedy is distinctly not found in sinking more wells into the same pocket; this reduces rather than increases the pressure in each. The bald fact is that all oil wells reach a summit of production not long after they "come in," and then slowly decline until they reach a point where the decision must be made between abandonment and pumping. And an equally bald fact is that of all the oil estimated to be present in a given location, it is seldom possible to bring to the surface more than half.

At this moment there is but one substantially new oil field in the world—that of Oklahoma and northern Texas. Even this one is old enough to have passed its crest. It will go on supplying a lot of oil for a long time; but it cannot be expected to hold out big increases. The characteristic fate of oil fields is seen today in Pennsylvania, where the wells that made the oil

(Continued on page 432)

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The object of this journal is to record accurately and lucidly the latest scientific, mechanical and industrial news of the day. As a weekly journal, it is in a position to announce interesting developments before they are published elsewhere.

The Editor is glad to have submitted to him timely articles suitable for these columns, especially when such articles are accompanied by photographs.

Building for the Future

So rapid is the rate of progress in every branch of human activity, and particularly in that great field which is covered by the term "engineering," that it is evidently the sheerest folly to plan and build merely for the present or even the immediate future. Far-sightedness is an indispensable quality in the planning of public utilities and the lack of it has placed heavy discomforts upon posterity. We are carrying such burdens today, and unless we lay to heart the lessons of experince, we and our children will be carrying even heavier loads in the future.

This is true in respect to transportation, particularly as it affects the great centers of population. We are proud of our rapid transit system in the city of New York. We have reason to be. Nowhere in the world can be found another railway system which carries so dense a traffic at such a high rate of speed and with such marvellous immunity from accident. Nevertheless, even in New York, with its six hundred miles of rapid transit tracks, we are suffering because of a lack of prevision during the previous decade.

When the original subway was planned, there were thousands of intelligent citizens who believed the proposal to build a four-track road from one end of Manhattan Island to the other was extravagant, and that the scheme was far ahead of any possible demands of the future. Such things were actually said and written. Nevertheless, the new subway had been running less than ten years when plans were made for more than doubling its total length and capacity; and, today, no sooner are new sections of the system opened to the public than they are crowded to the very limit.

It is the same with the railroads, although the congestion here is not so severe, is limited to special routes of travel, and may be more quickly relieved by the construction of parallel tracks. So far as steam railroads are concerned, there is call for clear prevision in the matter of bridge construction, particularly in respect to important crossings of rivers involving spans of great magnitude. The determining factor is the question of loads, and particularly of the concentrated loads resulting from the ever increasing weight of engines and cars. Of late years several important bridges have had to be strengthened and practically rebuilt, to meet a loading which was not dreamed of in the days when they were erected. In the case of two great cantilever bridges, one crossing the Niagara River and the other the Hudson at Poughkeepsie, a clearer vision of future traffic development, resulting in heavier cars and locomotives, would have postponed the costly and troublesome reinforcement of these bridges for many years.

A warning may well be given in respect to county bridges, many of which are being severely tried by the heavy loads which are being carried by several new motor-truck freight lines. The freighting of heavy loads by motor trucks over the highways of the country is destined, we believe, to become one of the most important traffic developments of the next few years, and it will be sound economical practice if the authorities in the various counties instruct their designing engineers to build all new highway bridges to carry loads much heavier than the maximum that is using the highways at the present time.

Trend of Motor Car Development

THE present era of high prices and the prospect of a great increase in the cost of gasoline are playing their part in determining the characteristics of the motor car of the near future. During a recent trip through the automobile manufacturing centers, the Editor found that there was a decided effort both to reduce the weight of the car and secure a greater number of miles per gallon of fuel. In several cases leading manufacturers are developing cars of medium weight and power, whose fuel consumption is less than one-half that of their heavier cars and whose weight does not exceed 3,000 pounds. In one instance, the manufacturer stated that the lighter car, with half the number of cylinders and only two-thirds of the weight of their heavier cars, would nevertheless show an all-round performance that was within 90 per cent of that of the more powerful and heavier machine.

It is noteworthy that in the case of the medium-weight and medium-priced cars above referred to, the avowed object aimed at by the designing engineers was to obtain much greater mileage per gallon of fuel and so be prepared to meet the inevitable increase in the cost of gasoline. To this end builders are disposed to abandon the multi-cylinder engine in favor of four or six cylinders and raise the revolutions to from 2,700 to 3,000 per minute. Obtaining power through increase of the speed factor means a proportionate reduction of the weight factor, and experience has shown that for the same output of power a small high speed engine is far more economical than a larger engine running at lower speed. There are many elements which contribute to this economy, such as the small size and light weight of the reciprocating parts and the considerable reduction in cylinder leakage; and cylinder leakage, by the way, not only means increased fuel consumption, but the gas which gets by into the crank case thins down the lubricating oil with the resulting effect of greater friction and more rapid wear of the bearing surfaces.

Recent developments in the production of aluminum alloys of high tensile strength are having, and are bound to have, important results favorable to even higher speeds of revolution with all the attendant economies and other advantages. Aluminum alloy connecting rods with a tensile strength of 55,000 pounds to a square inch have been made and tested on the road, and they have stood up without any signs of failure. These rods show a saving of two-thirds in weight over steel of equal strength.

The possession of an aluminum alloy of such great strength opens up new possibilities in cylinder construction, and good progress has been made in the past year in the production of aluminum cylinders with extremely thin liners of steel. The advantage of such cylinders is that their capacity for radiation of heat is two-thirds greater than that of iron. Although this is unfavorable for water-cooled engines, it is ideal for those that are air cooled. Consequently, it is not surprising to find that several automobile engineers consider it quite possible that we may see in the future an extended use of light, high-speed, air-cooled engines which will show a very high mileage per gallon of fuel.

More than one of the new cars is equipped with a device for pre-heating the fuel, and it is claimed that they are showing a very decided reduction in fuel consumption. It is evident from the above that the fuel question is the dominating question in automobile design, and there is reason to believe that, for some time to come, the increasing fuel cost will be fairly well offset by the reduction in fuel consumption. It should be borne in mind that the saving does not rest with the engine itself, since the lighter cars will impose less heavy service upon the tires, and, indeed, upon the whole structure of the car.

Taking Chances

IT is high time that we stopped taking gamblers' chances with our National safety. We insure our buildings, why not our country? Especially as by Universal Training we can insure it on the endowment plan—the plan which not only provides insurance but returns the premiums with interest. The truth is that we owe our national independence and safety to good luck and 3,000 miles of water.

We won the Revolution: because England was involved in European wars and because of the difficulties, in the days of sailing vessels, of operations across an ocean 3,000 miles wide; also because many of the great popular English leaders were opposed to the policy of King George III and his minister, Lord North.

The war with France in 1802 was on paper only. In the war of 1812, England was under much the same difficulties as in the Revolution. Our capital was burned and the result was little better than a draw. We quickly won the Mexican War because the handful of disciplined troops and trained officers that we had were sufficient. In the Civil War, both sides were unprepared and the victory fell, as was inevitable, to the side that had the navy and the factories.

The war with Spain was really a naval war and was won by us because our Navy was sufficientiy prepared for the particular emergncy while the Spanish ships were but death traps for their gallant sailors.

Our three serious wars—the Revolution, the war of 1812 and the Civil War—could have been successfully terminated in short order, with small loss of life and at trifling cost by a single army corps (or less) properly trained, led and supplied. Lack of preparation dragged these wars out for years, left the result to mere chance, and cost us dear in blood and treasure.

Shall National defense continue to be neglected on any theory that there will never again be war? The April issue of the *National Service* magazine chronicles some fourteen wars now in progress. The suggestion was made in the House of Representatives that it is unnecessary to provide for National defense because we always have the veterans. The slogan of this proposal is "Let the veterans do it; they know how." Apart from the obvious unfairness of any such proposal, it is clear that if the veterans are to be drafted to fight our future wars the necessary draft law should be passed at once, because everyone has learned the folly of waiting to prepare until once war is declared.

It was for the principles enunciated by the Senate bill for Universal Training, as discussed elsewhere in this issue, that the Military Training Camps Association and others contended *before* the war. Under the general apathy toward questions of National defense then prevailing, the best that could be accomplished was the giving of a month's training to some 22,000 men, chiefly at their own expense, in the civilian training camps of 1913, 1914, 1915 and 1916.

Though Universal Training legislation was drafted long *before* the war, the selective draft act was not passed until May 18, 1917, or nearly six weeks *after* war was declared and the first drafted men from the 500,000 quota did not reach camp until October of 1917, and the last until February, 1918. It was not until July, 1918, that the first 150,000 men were ready for battle in France. Within three months thereafter, that is by October, 1918, we had already about broken down in replacements—both officers and men—and men who had never fired a rifle or worn a gas mask were being fed into the firing line to sacrifice their lives often unnecessarily. A little more fighting and our army would have been made up chiefly of untrained men. Our men fought with foreign artillery, machine guns, ammunition, tanks and airplanes, and were otherwise largely supplied by foreign help and with foreign motor trucks. The war was over, thanks to the tenacity of the Allies and the moral and industrial collapse of Germany, before our munitions, contracted for at staggering expense, could be produced and transported.

Our program was to land 4,000,000 men in France, with supplies at the rate of 25,000 tons a day for each million men, or an ultimate total of 100,000 tons a day. At the close of the war we had over 2,000,000 men in France, but had never landed an average of more than about 26,000 tons of supplies a day, though we had not yet really begun to ship artillery, cannon, ammunition and tanks and were far behind in requirements for motor trucks, railway rolling stock, engineering material, animals and forage.

Let us stop risking our National safety and insure it by an adequate and American system of defense. We can do this by passing Senate bill No. 3,792.

Automobile

The Paris Traffic Tangle was recently attacked, by request, by an American officer who undertook to instruct the French policemen in the American system. All went well until the first occasion on which a driver failed to observe the "cop's" signal. The outraged officer at once abandoned his station to engage in pursuit, and traffic regulation on that particular corner promptly went to the dogs.

A Non-Chattering Clutch of the single-plate dry-disk type has just been put on the market by an American concern. A simple adjustment of the friction disks compensates for wear, while the rapid and positive disengagement is claimed to eliminate any dragging tendency when releasing. Misalinement between transmission and engine is taken care of without any possibility of binding on disengaging.

Ignition Magneto Installation.—Gear drive is the best method of driving a magneto armature and direct spur-gear connection is better than either bevel or spiral gear trains because it is the best wearing form of gearing. Silent chains may be used for driving if some form of adjustment is provided to compensate for chain stretch. When a magneto is driven by a shaft, it is customary to provide some sort of a universal joint or Oldham coupling between the armature and the driving member in order that any inaccuracies in alinement of the driving shaft will not stress the ball bearings supporting the armature. It is desirable to protect the instrument from oil or water by placing it in a case of rubber or leather and in modern types, the contact breaker and distributor housings are closed by easily removed dust-tight coverings.

Wear on Roads by Heavy Trucks.—To determine the destructive effect of heavily loaded auto trucks on highways and streets, and to meet the demand for data on the design of road surfaces and foundations to withstand such heavy traffic, a series of experiments is being conducted by the Bureau of Public Roads to determine the impact of auto trucks on roads. The most striking single development in the highway field in 1918 was the tremendous increase in motor truck traffic. Five years ago heavy motor trucks were few in number and limited practically entirely to the paved streets of larger cities. These vehicles now comprise probably 4 to 5 per cent of the grand total of all motor vehicles and are to be found wherever traffic conditions permit profitable use. But very few roads were designed to carry any large volume of this class of traffic. Consequently, the cost of adequate maintenance was increased greatly during the year. In many places the damage claimed to be due to the incessant pounding of these fast and heavy vehicles was so great as to require complete reconstruction. Roads must be built to stand the new traffic as these motor vehicles are now a necessity in our daily life so it is expected that information of value will be obtained from these tests.

Roller Contact Timer Troubles.—When a timer of the roller contact form is used, ignition is apt to be irregular should the spring attached to the end of the roller arm break. If the interior of the device is filled with dirty oil, the current is apt to be short-circuited. If the device has been oiled with a lubricant having too much body, the roller is not apt to make good contact with the metal segments and ignition will be erratic. Depreciation in the bearing pin on which the roller rotates or of the fulcrum pin on which the roller arm swings will also result in irregular ignition. If the motor runs steadily at low speeds but misses fire at high speeds, and the trouble has been traced to the timber, it is necessary to feel around the inside of the fiber ring with the finger to see that this is smooth and perfectly round, and that the contact block faces are flush with the surface of the ring. If the blocks are worn below the surface of the ring, the roller is apt to jump the space at high speeds due to the low block and not establish an electrical contact. At low speeds the tension of the spring is sufficient to keep the roller bearing against the contact blocks, as it will follow the irregular contour of the timer interior without difficulty. If the segments are badly worn and the fiber ring roughened, the timer casing should be chucked in a lathe or grinding machine and the interior ground smooth and perfectly round with a small emery wheel.

Astronomy

The South American Observing Station of the Smithsonian Astrophysical Observatory, located at Calama, Chile, will be taken over by the meteorological service of Argentina, if tentative arrangements already made to this end are approved by the Argentine Government. This transfer would set free funds of the Smithsonian Institution for a solar station in Egypt.

A Committee on Stellar Parallaxes was appointed at the initial meeting of the International Astronomical Union, held in Brussels last July. All the institutions in the United States which are actively engaged in stellar parallax work are represented in the membership of the international committee, and thus the corresponding committee of the American Astronomical Society appears to have become superfluous.

New Asteroids and Their Orbits.—According to Dr. Cohn's annual report on the minor planets, published in *Astronomische Nachrichten*, two of those to which numbers have recently been assigned have orbits of special interest; viz., No. 898, on account of its high eccentricity, amounting to nearly 0.4, and No. 911, which is the sixth known member of the Trojan group, the mean motions of which are the same as that of Jupiter. Nos. 895 and 914 are remarkable for large inclinations, exceeding 25 degrees in each case. There are now 914 of these little bodies to which permanent numbers have been assigned, besides several hundred others which have not yet been adequately observed.

Accurate Meteor Orbits.—Prof. C. P. Olivier, president of the American Meteor Society, calls attention in a recent paper to the fact that we have, as yet, little accurate knowledge about meteor orbits. This fact, he says, needs to be emphasized, since in textbooks as well as in memoirs we find discussions of the orbits of meteors in which they are classified according to what conic section they belong to, as though such facts were certainly known. In many of these cases a change of only a tenth of a second of time would have totally changed the elements of the orbits, and in excessively few cases would an observer claim so great an accuracy in his estimation. An instrument for making accurate observations of meteor paths is urgently needed. Such an instrument was planned by the late Prof. Cleveland Abbe, and Prof. Olivier hopes that funds may be secured for making instruments according to the plans and giving them a thorough test.

The Young Moon Seen as a Circle.—A paper by T. L. MacDonald, read before the British Astronomical Association, discusses the appearance of a bright border along the lark limb of the young moon. According to Mr. MacDonald this luminosity, which is not visible in all lunations, has a more or less line-like appearance, and is decidedly brighter than the ordinary earthshine, which always illuminates the darker part of the young moon. The bright border varies in length, not always extending as far as the horns of the lunar crescent, and certain nearly circular swellings of intensified brightness have been noted. In general the border is most sharply defined when the moon is 2½ days old, and it begins to become diffuse the third day of the lunation. By the seventh day it is barely distinguishable. Commenting on these observations, Mr. Harold Thomson stated that he had observed the bright border with the naked eye, but it disappeared in the telescope.

Naval Observatory Time Signals.—To illustrate the accuracy of the time signals sent out by the U. S. Naval Observatory, especially as distributed by wireless, Mr. C. C. Wylie, of the observatory staff, has recently cited the record of a specimen month (February, 1919). Each signal is recorded on the chronograph with the standard clock so that the error may be accurately determined. The errors in setting the transmitting clock were almost negligible; viz., 2 of 0.02 sec., 21 of 0.01 sec., and 5 of 0.00 sec. Due to erroneously forecasting the rate of the standard clock there were, however, larger errors, the maximum being 0.08 sec. To the signals from the three wireless stations operated by the transmitting clock of the observatory the corrections for lag have been determined as follows: Arlington, +0.02 sec.; Great Lakes, +0.10 sec.; Key West, +0.28 sec. Whenever great accuracy is required, it is advisable to use the messages distributed by wireless rather than those sent over the ordinary telegraph lines.

Engineering

Electrification in Brazil is receiving considerable stimulus from the work on the Paulista Railroad. Engineering service has already been enlisted in the United States, and a contract made for the power to be consumed when the project is finished. The minimum consumption specified in this contract is 8,400,000 kilowatt-hours, with a possible increase to a maximum of 20,000,000.

Building Construction in Malaya.—It is reported that reinforced concrete is being adopted to a large extent in the Straits Settlements and nearby regions in an attempt to solve the problem caused by the shortage of houses; and that this is occurring not only in the case of dwellings but in other directions, such as the construction of a ferryboat to convey the railroad across the Johore Straits. A number of bridges will also be built of this material during the coming year. The manufacture of bricks and tiles is also booming in this part of the world.

After a Flood that had severed all communication between the two halves of West Point, Ga., which straddles the Chattahoochee River, some interesting emergency measures were taken. The side of the town across the river from the reservoir was connected up again with the water supply by hanging a four-inch main on the wreck of the bridge. Through traffic over the bridge had been considerable, and this was accommodated by two ferryboats thrown together in short order. In connection with the suspended water-main, an aerial board-walk was likewise installed to take care of pedestrian traffic across the river.

Concrete Tanks for Water Storage.—The test of tanks of 1.2:4 mixture, undertaken by the Bureau of Standards, has been discontinued after 150 days, because the curves showing the daily loss of water have taken the form of straight lines, showing that this loss has become constant. The tanks, although showing actual loss due to water penetrating the concrete, kept this loss down to such a low figure that the exterior of the tanks was always dust dry. It would seem from this that, though the head of water amounted to 35 feet, the 1:2:4 concrete is sufficiently waterproof for water storage.

Cement Fiber, a product made in the past in France and Germany, but not commercially in this country, could be made a by-product of American cement plants. Since it will not rust like corrugated iron, it is desirable for building in the tropics or in damp climates. In addition to being thus free from atmospheric action, the fiber is non-combustible; and its superiority to corrugated iron is emphasized by the fact that it conducts neither heat nor electricty. Although it can be sawed, filed, perforated and nailed, even along the edge, it can be neither split nor broken readily; and exposure to the elements serves merely to make it harder. The product can be manufactured economically and sold more cheaply than metal articles for similar purposes.

Restoration of Belgian Railroads.—The reconstruction of tracks, bridges, tunnels, embankments, etc., on the roads of Belgium since the armistice has been all that could be desired; but the restoration of the rolling stock has progressed less favorably. In fact it is the acute shortage of rolling stock that today controls the situation and hinders the reviving industries of the country. The locomotives in active operation show a decrease from 3,757 in July, 1914, to 2,479 at a recent date. Cars likewise show a shortage, in spite of the presence of many reclaimed cars from Germany, which are in anything but the best of condition. Since the early part of October trains have been running over all lines that were in operation at the outbreak of the war, though in some cases double track lines have become single track for the time being. Of tunnels and bridges destroyed during the war 746 have been completely restored and 594 provisionally replaced. Prewar schedules, however, have quite generally failed of complete re-establishment, even on the lines which are in the best shape. This is due in the main to the lack of equipment. There is a good deal of friction between the beet and the coal traffic, each claiming precedence over the other—the one because of the importance of the sugar industry to Belgium and the other for obvious reasons.

House Surgery in the Building Crisis

The Remodeling of Old and Obsolete Houses to Create Pleasing Modern Dwellings

By C. L. Edholm

WITH building material prices high and going higher; with labor asking higher wages and with a housing shortage that is almost a famine, from coast to coast, a distinguished New York architect has found a partial solution of the problem by the method that he terms house surgery.

The process means the remodeling of old buildings to meet the modern demands of comfort, health and beauty, an undertaking that may run from 40 to 60 per cent of the cost of a new structure, according to the general estimate of Mr. Henry J. Davison, who has handled such contracts and planned the remodeling of farm houses, suburban homes and city dwellings in great number.

The standards of living change so fast in this country that a house which our grandfathers considered luxurious is regarded as little more than a tenement by their descendents, and the usual custom has been to rent the old house for a small amount, or to tear it down and build something brand new on the site; a wasteful method in either case. In the old days, a house of twenty rooms might get along with only one bath room. Today the rooms are smaller, and the bath rooms numerous. Ideas in stairways and reception halls have changed completely. The old time hall was a dark and unattractive tunnel, with a staircase going straight up to the floor above, a gloomy place to hang your hat and coat and leave as soon as possible. Today the reception hall is broad and cheerful and has inviting nooks that make you want to linger, while the staircase ascends by easy stages and does not appal a short-winded visitor by a steep, unbroken ascent.

We have different ideas today about floors and windows and fireplaces and scientifically arranged kitchens, so that a house dating from the sixties, seventies or eighties appears to be hopeless to a modern home-seeker.

Yet it is possible to make all the needed changes, while retaining the most expensive parts of the house, such as the foundations, roof and main walls. Very often the old house is more substantially built than a modern structure. Honest masonry and well seasoned lumber have lasting qualities that defy a few decades, and they should not be destroyed just because the modern conveniences, such as electric lighting or improved heating systems, are not installed.

One of the big reasons for neglecting old houses is that remodeling has too often been just patchwork. If electric wiring is added, it may be attached to the surface of the walls, and the ugly gas chandeliers retained. By patchwork additions, the old house simply loses its remnant of good looks, and the occupants are ashamed to have callers because the home is so shabby.

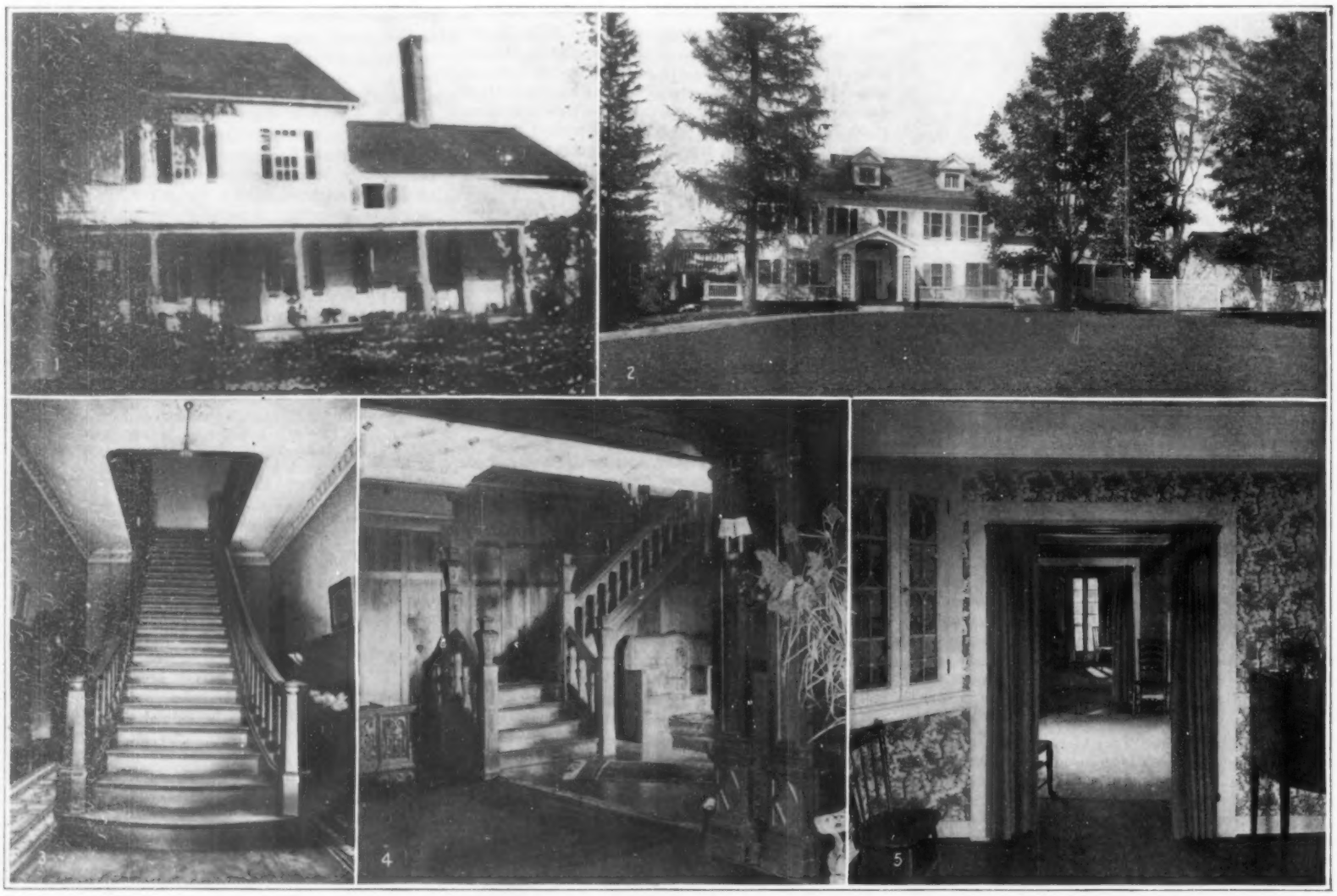
House surgery is not patchwork at all, but begins with a complete study of the house, without and within, to determine what possibilities there may be in the shell. The foundations, walls and roofs are examined to strengthen them if required. The entire outline of the dwelling may be changed, old fashioned towers and turrets may be lopped off; verandas removed and replaced by sun parlors; meaningless decorations and "gingerbread" ornament taken down and a more artistic style substituted.

Often the house is not to be recognized as the same structure after the exterior has been rebuilt. An architectural jumble of gables and porches was cleared up, and a lovely Italian villa replaced it. A typical New England farm house that looked as bleak and depressing as a hard winter, was rebuilt so that it had a charming and hospitable effect, while retaining the appearance of a farm house. Only it made you think of springtime on the farm, and apple blossoms and grassy meadows, instead of frozen slush. The photographs bring out the difference very clearly. Without the artistic vision of a builder such as Mr. Davison, this lovely home would have gone the way of other abandoned farm houses that are so frequently seen in New England, but today it is a comfortable and modern residence, with sixteen rooms, plenty of baths, servants' quarters, large guest rooms and living rooms. It is serving its purpose instead of going to wreck and ruin.

The interior of this house was a matter of difficulty because the ceilings were very low, but the view of one of the connecting suits shows that a skillful decorator can solve such difficulties. House surgery is a matter of interior decoration as well as rebuilding, for the final result is to be a home that is beautiful as well as livable, and it is not only a matter of shifting partitions and adding conveniences, but arranging attractive colors and lines in the furnishing and hangings.

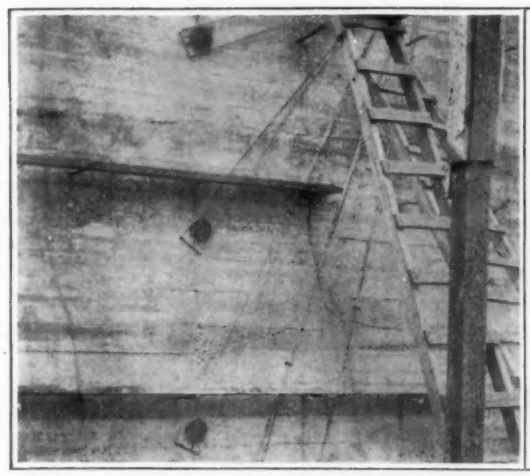
One reason for the modern housewife's dislike for the old-style house is the ugly, depressing and faded colors of the interiors dating a generation back. So a case of thoroughgoing house surgery would include a new

(Continued on page 432)

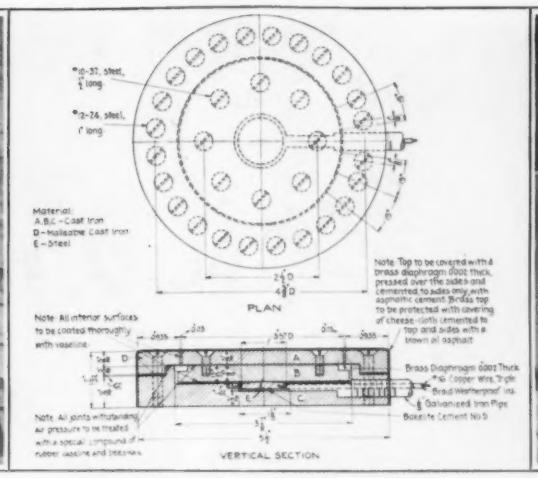


1. A relic of generations gone, in which no family of today would think it possible to live. 2. The bleak farm house of the first picture after the doctor of old houses had practiced his arts on it. 3. A typical old-fashioned entrance hall—a dark, narrow passage and a steep flight of stairs. 4. The same hallway after the application of house surgery. 5. Attractive bedrooms in a remodelled farm house.

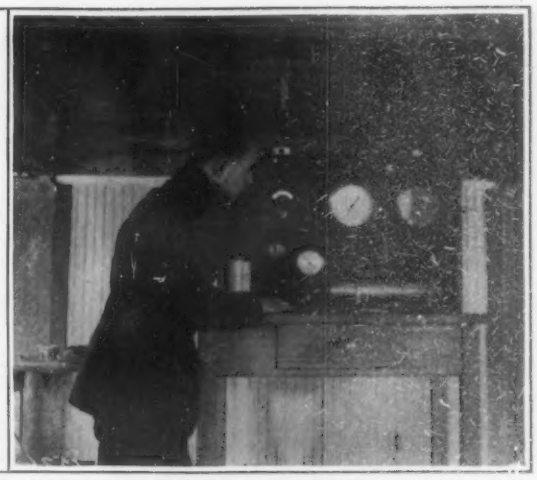
How the house-surgeon works to transform old and seemingly hopeless houses into attractive, modern dwellings



Diaphragm cells installed on the wall of a concrete dam



Details of the diaphragm cell for determining soil pressure



Apparatus connected with the diaphragm cells and indicating pressure at all points

Details of the newly-introduced diaphragm cell which indicates the pressure at different points of a dam

Is the Dam Safe?

By S. R. Winters

A RECURRENCE of the Dayton, Ohio, flood and similar inundations destructive to life and property, due to the collapse of enormous dams, may be averted if the possibilities of a mechanism designed by A. T. Goldbeck and E. B. Smith of the U. S. Bureau of Public Roads are fully realized. Essentially, the scientific discovery is visualized in an instrument for accurately measuring pressures produced by granular materials and thereby permitting of the control of earth dams during construction so that they may safely withstand future floods.

Of course, the instrument is impotent to control river overflows or disasters from earthquake convulsions, but should prove a helpful agency in making for safe construction and thus avert floods similar to the Johnstown, Pa., catastrophe of 1889, wherein this flourishing manufacturing center was annihilated by the bursting of a dam ten miles above the town. As a safety control, five flood-protection dams in the Miami Valley, Ohio, now in the course of construction are being equipped with these soil-pressure cells, the experiments forming the basis for an exhaustive study of durable materials and engineering skill in the building of "safety-first" dams in the Miami Conservancy District.

Determining pressures at varying depths in a liquid is no untried process nor is it difficult of attainment, but the pressures due to granular materials are exceedingly difficult of comprehension, with scientific precision. Chief of the obstacles in the way of obtaining correct measurements of the earth fills is the weighing instrument itself—it must be so equipped as to obviate disturbance of the earth or other granular substance during the process of pressure-measurement. Seemingly, the instrument of the U. S. Bureau of Public Roads surmounts this obstacle. Moreover, the observer may take his readings even though the pressure cell is buried 100 feet deep in the earth.

Pressure cells are buried in the cores of the Miami Conservancy District dams at 10-foot vertical intervals as a method of obtaining the changing nature of the materials. Three wooden towers are stationed at three points embracing the width of the core, the pressure cells being hung within these towers by wires counter-weighted over sheaves at the top. This arrangement permits any cell to move in harmony with the surrounding soil as it settles. Cells are not fastened laterally; however, in the middle tower lateral-pressure cells can be located at 10-foot intervals and vertical-pressure cells at spaces of 30 feet distance. In the other towers the corresponding intervals will be 10 and 40 feet. An airpipe containing also an electric indicator wire is elevated from each cell to the tower top where the observation readings are taken.

Briefly described, the soil-pressure measuring instrument consists of an air-tight cell made of cast iron, visualized in diameter as corresponding in size to that of a saucer. The top portion of the cell is attached to the bottom compartment by means of an extremely thin brass diaphragm—which is about as thick as a strip of paper and comparatively as flexible. Water-proof covering protects the cell from moisture. Leading into the cell is a small airpipe through which is also laid an electric wire.

Suppose you desire to ascertain the pressure measurements of a high retaining wall: First attach the instrument to the wall before the earth fill is placed in contact with the wall, and the small pipes leading from the cells are laid up to the top of the wall. After the earth fill is made, readings of the pressure are taken by use of an indicating box in the following fashion:

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California's Power Famine

By Charles W. Geiger

THE water power shortage in California at the present time is said to be the most serious in the history of the State. Not since 1851 has there been such a lack of rain. Due to the unprecedented dry spell, all of the big power companies serving San Francisco, Oakland and other large cities now are compelled to utilize their steam plants to generate nearly half the load. Such use of steam plants as auxiliary to the hydroelectric plants by the California companies is the normal condition between midsummer and the early rains in winter, but this year because of the continuing dry spell the pressure upon the steam plants has become a great deal heavier than usual and is continuing longer.

Ordinarily about 25 per cent of the power in California is generated by the steam plants. Last year 27 per cent of the power used in the north was generated by steam plants, 13 per cent by hydroelectric plants from water impounded in storage reservoirs, and 60 per cent by hydroelectric plants from the unregulated flow of the streams. Heavy rainfall during the next two months may fill the reservoirs, but the season is now so far advanced that there is hardly a chance that the stream flows—the most important factor in the power situation—can be brought up to normal. Power shortage will become acute early in June and will not be relieved until the rains commence in the fall or winter of 1920.

Users of electric power up and down the valley and in the city of Fresno began on February 6th the shift to night work in order to conserve the electric power and aid in the shortage which is prevalent in the valley, as well as in the entire state. Most of the

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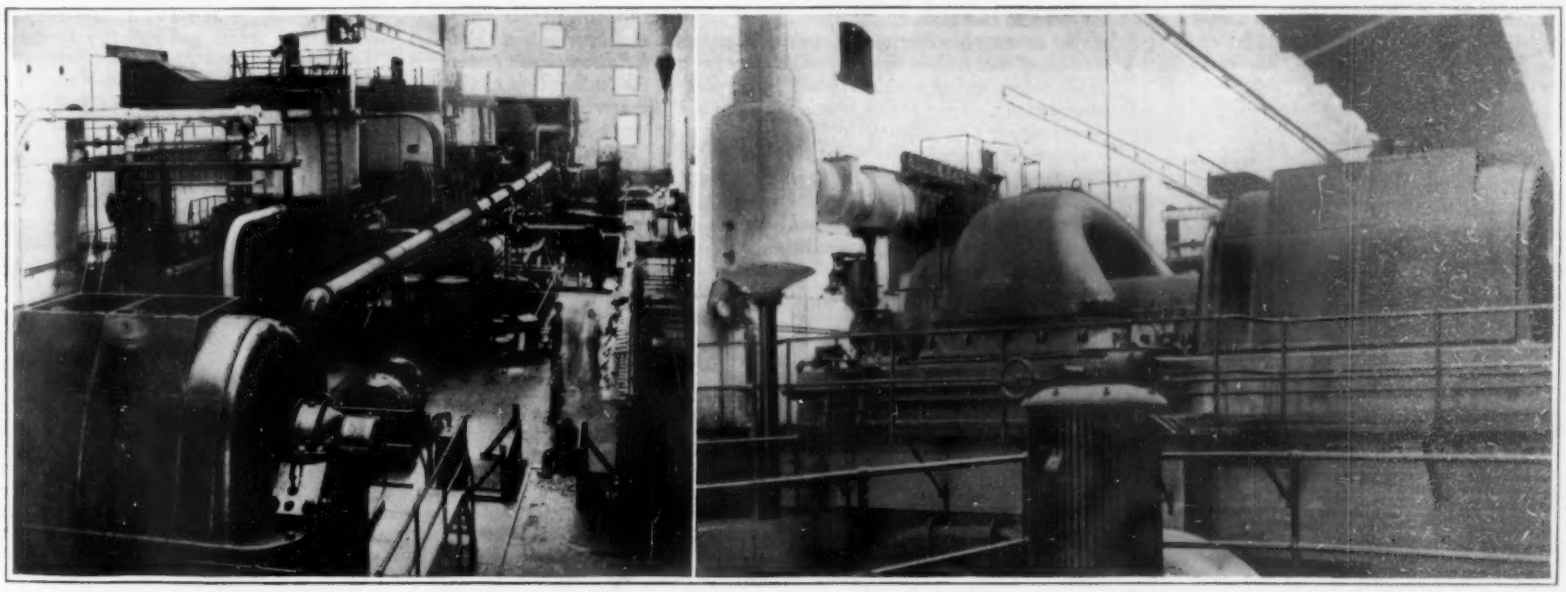


Left: New horizontal turbine of 15,000 kilowatts capacity in foreground, contrasted with a 3,500-kilowatt reciprocating-engine driven generator in the extreme background, which formed the original equipment of the station. *Right:* A closer view of the huge new turbine

Oil-burning steam-power plant recently completed in the California oil fields, just in time partly to relieve the serious hydroelectric shortage due to the dry season

Left: Sixty-inch searchlight of 1,600,000,000 candle-power. *Right:* A complete gyro-compass outfit, with the tell-tale instruments for distribution throughout the ship

Elmer E. Sperry and two of his products

The Romance of Invention—XI

Elmer Sperry—The Man Who Harnessed the Motion of the Earth

By C. H. Claudy

TITLING a story of a great inventor, or an epoch-making invention, is sometimes a labor of great difficulty. Other times it's merely an exercise of the pleasures of choice. It would have been almost equally applicable to speak of Elmer E. Sperry as one who "took the roll out of the sea" or as the "father of high-power searchlights" or as the man "who points the way for ships"—since the gyroscopic compass must always stand as the first real improvement in the mariner's direction finder, supposedly invented by the Celestials some thousands of years ago, before the beginning of history.

But of all the amazing things accomplished by the subject of this sketch through his inventive genius and his lack of understanding of the meaning of the word "can't," none makes a greater appeal to the imagination than this—that Mr. Sperry is the first and indeed the only man to use the motion of the earth as it revolves about its axis, and to make it of service to mankind in producing a true meridional pointing instrument.

As this unique utilization of natural forces can be explained, if explained at all, only by the most abstruse mathematics, no attempt will be made here to set forth the underlying "why" of the behavior of a gyroscope. A gyroscope, in its simplest form, is a wheel and axle, so mounted that the axle is free to take up any position in space. A gyroscope with its wheel spinning, indeed, any wheel spinning on any axle, is movable in space without exhibiting any special peculiarities, so long as the movement is such that the axle remains parallel to its initial position. But if any effort is made to twist the axis of the spinning wheel, it resists that effort, and the resistance results in a motion of the axis at right angles to the direction of the applied motion.

This is true, whether the applied motion be the result of muscular effort of a hand, holding a small gyroscope, or the motion due to the force of gravity. And the result is both curious and beautiful. A spinning wheel, with its axis free to turn in any direction in space, that axis acted upon by the force of gravity, gradually but surely so arranges itself that the axis of the spinning wheel is parallel to the meridian, so that the axis of the wheel points true north and south.

It was this principle which Mr. Sperry employed. The result is the gyroscope compass, which has entirely superseded the magnetic compass on all submarines, destroyers and battleships and is rapidly replacing them on all merchant ships of any size and pretensions.

Inasmuch as the Sperry gyroscope compass is a delicate, somewhat complicated and expensive instrument, requiring electrical power for the propulsion of its gyroscope wheel, and of course subject to such derangements as may come to any piece of machinery not properly cared for, it may occur to some to wonder why so elaborate a piece of apparatus should be preferred to the much more simple magnetic compass.

The answer is easy. A magnetic compass doesn't point to the true north at any time, but to the magnetic north, and a magnetic compass is subject to wild vagaries on steel ships—especially and particularly battleships, where huge masses of steel are constantly shifted in position (the great guns in a turret) and where some of those masses of steel are constantly changing the strength of their magnetic influence or even reversing it (as happens with a big gun every time it is fired).

The power which keeps a Sperry gyroscopic compass pointing to the true north is the power of gravity and the changeless revolution of the earth around its axis. No gunfire, no ship rolling, no change of course, no alterations in the magnetic value of the mass of the ship affect the gyroscope. So long as the little wheel or wheels are kept spinning, the compass points to the true north—and so do the other tell-tale compasses, from one to thirty-five in number, distributed about the ship, all electrically connected to the Master Compass.

It all sounds very simple. Given a piece of apparatus which points its axis to the true north and nothing apparently could be simpler than to attach a compass card to the frame and call it a compass. But between the theory and demonstration with a toy compass, and the complete apparatus, lay a world of mechanics to conquer and a hundred problems of practice to solve. A gyroscope does not whirl over and point true north as if possessed of magic. It takes a considerable period of time to swing to the true north. If left alone it will swing past the true north, stop, swing the other way and so, surely but very slowly finally come to rest pointing its axis to the axis of the earth. But a *compass* must be *quickly* responsive.

A magnetic compass card is supported so that the needles beneath may turn it with the least effort. A magnetic compass card and needles are very light. A gyroscope is a heavy piece of apparatus; wheels and electric motors cannot be made without weight. If all this apparatus is to be made quickly responsive it must be, first, delicately balanced; and, second, moved mechanically in response to the gentle, slow effort of the gyroscope itself to keep parallel to the earth's axis. No pivot, no matter how delicate, will do, because of weight and the possibility of wear or breakage. Mr. Sperry solved the difficulty by suspending his apparatus with a fine piano wire. And to keep the piano wire from twisting

(Continued on page 434)

BELL is a telephone engineer; Wright and Curtiss are aviation engineers; Baekeland is a chemist; Sprague an electrician; Pupin a physicist. These men have many inventions to their credit, each in his field; seldom or never do they venture outside that field. But Sperry is a third example of that catholicity of inventive effort for which Edison stands in the public mind, and of which Acheson is convicted in the tenth article of the present series. Everybody connects his name with the searchlight and with the gyroscope; everybody does not know that in addition he has to his credit fundamental advances in mining machinery, storage batteries, oil engines, electric automobiles, electrochemistry, and various other lines. Like Edison and Acheson, he seems to invent because he just can't help it—not merely because he is doing pioneer work in his chosen, special field and a pioneer is bound to strike on things new and useful. So in the case of Sperry far more than in that of most of the men whom we have used to exemplify the romance of invention, we may deliberately withhold the title of "engineer" and as deliberately apply that of "inventor."—THE EDITOR.

At the Rock Bottom of Matter

A Popular Explanation of a Much Discussed Theory Based on New Discoveries

By Dr. Irving Langmuir

EVEN the ancient Greeks thought of matter as being made up of atoms, but they did not know how to prove it. For the last century the science of chemistry has been based upon the theory of atoms. However, during the last twenty years we have come to count atoms, to measure their diameters, and determine their exact motions, till the characteristics of matter and in fact nearly all natural phenomena are thus the result of the behavior of the individual atoms. We can no more understand such phenomena without taking into account the nature of the atoms than we could hope to understand politics without a knowledge of human traits. The future development of science and even of its practical applications thus depends in large measure upon our familiarity with the characteristics of individual atoms. We must learn to know the structure of the atoms and the way in which they act on each other. The following theory is a step in this direction and serves to correlate a mass of hitherto disconnected chemical facts and to put chemistry on a more rationalistic basis.

According to our present views, all forms of matter are built up of atoms, but we no longer regard these atoms as indivisible nor even as simple structures. If a lump of ordinary matter the size of a baseball could be magnified to the size of the earth, the atoms in it would then have become about the size of baseballs. In other words, an atom is about as big compared to a baseball as the baseball is when compared to the earth. The atoms are constructed of particles of positive and negative electricity arranged in every open structure. All the positive electricity is concentrated into a very small particle, called the nucleus, located at the center of the atom. The negative electricity exists in the form of electrons which arrange themselves in space about the nucleus. The size of the electrons and nucleus is small compared with that of the atom itself. Thus, if we imagine an atom magnified until it has a diameter of one mile, the electrons would be about five feet in diameter, while the nucleus at the center would be only the size of an ordinary walnut.

DR. LANGMUIR, one of the foremost physicists of the country, has been awarded the William H. Nichols Medal for 1919, by the American Chemical Society. He is assistant director of the Research Laboratory of the General Electric Company, and a graduate of Columbia University and the University of Gottingen.—THE EDITOR.

The electrons in different kinds of atoms are alike, but there are as many different kinds of nuclei as there are chemical elements, that is, about 92 in all. These differ from one another only in the amount of positive electricity they contain. Thus for the simplest element, hydrogen, the nucleus has a unit positive charge which is able to neutralize the charge of a single electron. A hydrogen atom then consists merely of the nucleus and a single electron. The next element, helium, has a nucleus with a double positive charge and the atom thus contains two electrons. In a similar way we find that the atoms of carbon have six electrons while oxygen has eight, aluminum thirteen, sulfur sixteen, iron twenty-six, copper twenty-nine, silver forty-seven, gold seventy-nine, lead eighty-two, and radium eighty-eight electrons.

These electrons do not revolve around the nucleus the way the earth revolves around the sun, but they are arranged in three dimensions in a series of layers or concentric shells surrounding the nucleus. The electrons are probably not stationary but each revolves in its own orbit about a certain equilibrium position. However, as we do not yet know much about these orbits, we can speak of the positions of the electrons in the atoms as though the electrons were located in these equilibrium positions.

The first two electrons in any atom form the first shell about the nucleus; that is, two electrons are much closer to the nucleus than any of the others. In atoms with more electrons the next eight electrons form the second layer; then comes another layer of eight. If there are still more electrons these arrange themselves in a layer of eighteen, followed by a second layer of eighteen, and finally there may be an outside layer of thirty-two electrons. It is the successive formation of these various layers which causes the similar or recurring properties among the chemical elements which underlie the Periodic Table of the elements, that is of such fundamental importance in chemistry.

The eight electrons in the second and third layers are arranged in a symmetrical way like the arrangement of the eight corners of a cube. This stable group of eight electrons is called the Octet. The chemical properties of the elements result from the tendency of the individual atoms to take up or give up electrons, in order to form these Octets. That is, the atoms strive to take certain stable configurations characterized by geometrical symmetry. They accomplish this in some cases by exchanging electrons with each other, while in some cases the atoms share pairs of electrons with each other—a sort of coöperative plan. The pairs of electrons thus constitute the chemical bonds between atoms, which play such a prominent part in chemistry.

This theory of atomic structure and chemical combination not only explains an enormous number of chemical laws which have been obtained by experiment, but it leads to important extensions and in some cases to modifications of these laws, while in other cases it has led to new relationships and has made it possible to predict correctly the properties of certain substances before these properties have been determined by experiment.

Correspondence

The editors are not responsible for statements made in the correspondence column. Anonymous communications cannot be considered, but the names of correspondents will be withheld when so desired.

Our Navy, as Built and Building, Most Powerful in the World

To the Editor of the SCIENTIFIC AMERICAN:

In view of the present discussion of our naval program, the following comparison of the relative strength of our navy and that of Great Britain, when our present construction is completed, may be of interest. I have not previously seen it made. The data is based on Jane's "Fighting Ships," 1919, and equally reliable sources.

In 1923 the total displacement of the English dreadnoughts, including those which will probably soon be broken up, will be 785,000 tons; of ours 840,000 tons. In battle-cruiser tonnage the totals will be 230,000 and 260,000 tons respectively, excluding the British "Indomitable" which is for sale, and the light battle-cruisers of the "Courageous" class which have been converted into seaplane tenders. The total battle fleet of Great Britain will, therefore, dispace 1,025,000 tons; that of the United States 1,100,000 tons, or 7 per cent more. The weight of a broadside salvo from their big guns will be about 475,000 pounds; from ours 580,000, or 23 per cent more.

Add to this the fact that the average age of the individual American ship will only be 4½ years from completion; that of the British 10 years. At the very moderate allowance of 5 per cent depreciation of the total, each year, to represent both wear on material and obsolescence of design, the total efficiency of the British tonnage must be reduced one-fourth compared with ours. (Over half our fleet has been designed since Jutland, and only one British vessel, the "Hood.") Our battle fleet is thus found to be 43 per cent. nearly half again stronger than the English. Our displacement will be concentrated in 33 ships against 42, which increases the advantage.

As to the other types, we both have about 325,000 tons of modern destroyers. The data concerning submarines is less reliable, but we are building rapidly and England is scrapping several groups, so the totals must be nearly equal. In modern light cruisers England will have sixty vessels totaling 300,000 tons against our ten and 75,000 tons.

In the air we are outclassed in both dirigibles and seaplanes, but even these advantages could hardly balance a 3 to 2 difference in the main fleets.

From these general figures it may be seen that, by 1923, we will have the most powerful navy in the world without laying down another keel. Great Britain is planning no new construction for several years.

BRANDON BARRINGER.

Princeton University.

The Milk Situation

To the Editor of the SCIENTIFIC AMERICAN:

The slap in the face which we dairymen recently received from the people of New York City will have its reaction in time.

The overproduction of milk is due to several causes. We had become over enthusiastic because of our success in organizing and developed the industry rapidly when many other branches of agriculture were at a standstill or on the decline. Many dairymen, however, saw rocks ahead and were not surprised at the slump. The sudden ending of the export trade brought the inevitable anticlimax unexpectedly.

The present situation proves very plainly that the consumer's little strike of a short time ago was ill-advised as it has prevented coöperation between the consumer and the producer. The city man thinks the farmer a grasping profiteer at five and one-half cents per quart for standard milk. Most farmers consider the New Yorker a narrow-minded, ignorant person who does not understand economic laws.

The surplus of milk will cause many producers to fear for the future; it will deter others from entering that line of work at all. The sheep may become the dairy cow's successor as there was more or less of a tendency in that direction before the recent decline in the price of milk, due to labor shortage.

The dairy cow lowers the prices of many things—that is to the consumer. She does not hurt the market for the producer of these things because she saves by-products. She eats wheat bran, cotton seed meal, molasses (of a low grade), oil meal (a by-product of paint and linen production), beet pulp (a by-product of beet sugar manufacture) and the refuse from the breakfast food factory. She reduces the price of wheat flour, cotton goods, sugar, linen, paint, varnish and other things too numerous to mention.

The consumer can expect to feel the decline in the dairy industry even to the soles of his feet as even the dairy cow has a hide. ROSCOE C. JONES.

Jefferson, N. Y.

Taking the Guess out of Photography

To the Editor of the SCIENTIFIC AMERICAN:

In connection with a short article under the above title on page 282 of your March 13th issue it might be noted that the attachment therein described is subject to certain limitations. Unless made quite large (and correspondingly expensive) the finder can include but a small portion of the picture and therefore does not aid in composition. Furthermore, the image on the ground glasses will be faint unless the subject is exceptionally well lighted.

The writer has found the following application of the Galilean telescope inexpensive and very useful. An objective of the same focal length as the camera lens is attached to the lens-board of the camera as described in your article, and any commercial direct-vision view finder (which is a short focus planoconcave lens) is mounted on the camera box in such a position that the distance between it and the objective equals the difference of their focal lengths. The finder is then used to compose the picture in the usual manner, but the two lenses form a telescope system which gives, in the center of the field, an enlarged image of a central portion of the object that is only sharp when the camera is correctly focussed on this object. No tubes connecting eye-piece and objective are necessary, and the auxiliary objective can be permanently attached to the lens-board by a folding arm so that it need not be detached in order to close the camera. This device is also usful, where the light is weak, in focussing a film camera or time exposures.

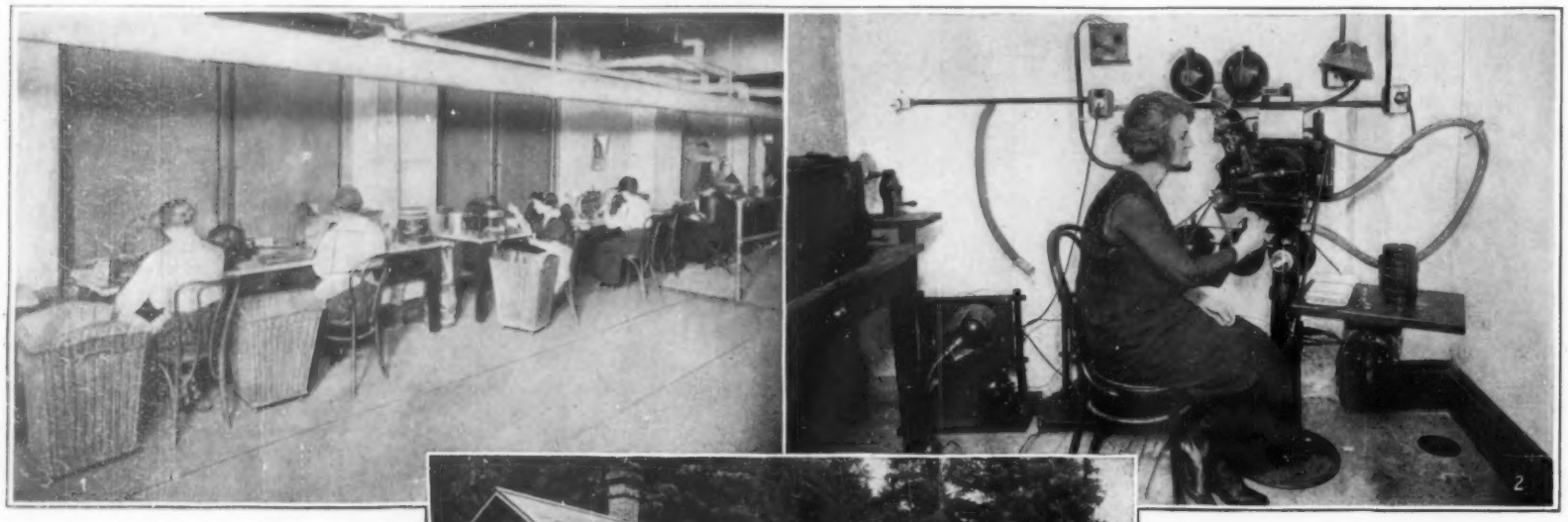
HERBERT K. CUMMINGS.

Picatinny Arsenal, Dover, N. J.

Uncle Sam—Motion Picture Producer

How the Department of Agriculture Is Bringing Special Film Features to All Parts of the Country

By George H. Dacy



1. Assembling, splicing and matching negatives in the Department of Agriculture film laboratory. 2. Uncle Sam's printing room 3. On location with a forestry film

Making Government movies for the entertainment and education of the farmer

UNCLE SAM is today busily utilizing the cinema and the facilities it affords for the elementary instruction of hundreds of thousands of country folks in the fundamentals of modern methods and practical farm operations. The Department of Agriculture has in circulation motion pictures covering 69 subjects, ranging from a one-reel production "How to Select a Laying Hen" to a bonanza picture composing eight reels on "The Story of Cotton," which pictures all the methods and processes involved in the production, milling and marketing of the king of southern farming crops. The films are intended primarily for the use of extension workers of the Federal and State Departments of Agriculture and of officially coöperating institutions. The county agricultural agents borrow or rent the projection machines of their respective local motion-picture houses and stage free film shows to instruct their constituents concerning the how, why, when and where of different agricultural processes and systems of management. A total of 410 reels is now available in this systematic campaign to extend scientific agricultural education. Thirty new subjects were prepared and released for distribution during the last calendar year, the present capacity of the Federal motion picture laboratory being about one reel, or 1,000 feet of negative, a week.

The demand for the Federal farming pictures has always been out of proportion to the supplies, so that the waiting list has been as long as a municipal soup line after a severe blizzard. The funds available to extend the work have never increased in correspondence to the rapid rise in rural popularity which has been accorded this innovation. Just to illustrate that the farming films are as well patronized as slapstick comedies and western melodramas, it is worthy of special mention that during the month of January, Uncle Sam's agricultural pictures were shown to 55,842 spectators. These screen displays have proved one of the most popular and profitable systems of simple extension work now employed by the Federal authorities to increase production and to insure the making and marketing of quality products.

Our foreign cousins—quick to appreciate and benefit in very way possible from American ingenuity, resource and achievement—have not been remiss in the rapid adoption and utilizaton of the Federal farming film. Australia, New South Wales, France, Spain, Japan, Chili, Peru, Argentina, Siberia and a host of other overseas countries have made extensive official use of these motion pictures in instructing their peoples about modern farming and scientific methods. Through the Committee of Public Information Uncle Sam has sent to Russia twenty agricultural motion pictures concerning agricultural production, highway construction and forest conservation. Eight good roads films have also been loaned to the British government, while our Department of Agriculture has coöperated actively with the Community Motion Picture Bureau in supplying films which have been exhibited extensively to both soldiers and sailors at home and abroad.

Through arrangements with one of the commercial companies, abridgements of sixteen of the government films were shown to approximately five million people. The demand for the farming films has been so keen that copies of them now are sold to various educational agencies at cost with the understanding that they are to be used only for instructive purposes and that no ad-

(Continued on page 436)

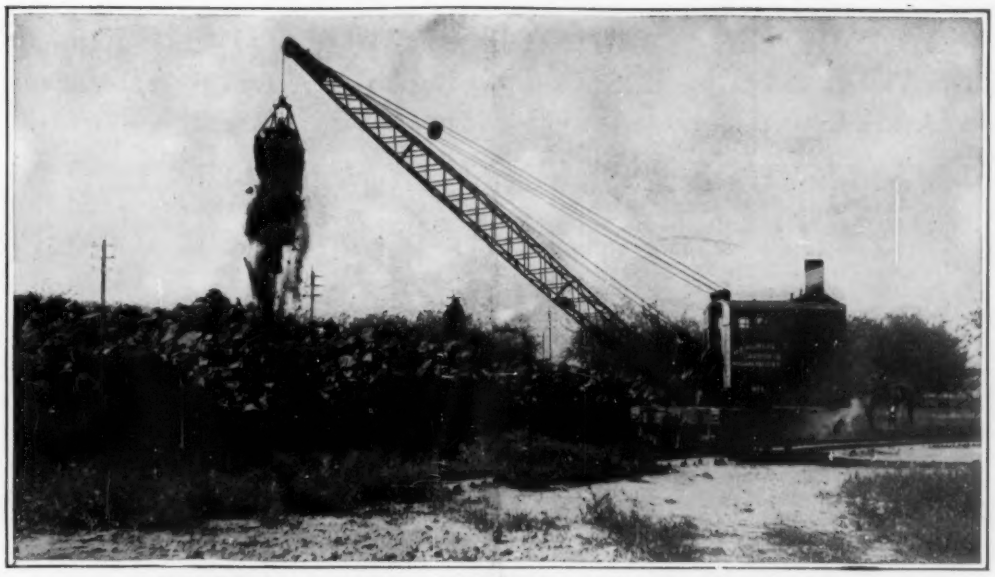
Typical scenes in the northwestern woods as produced in the Federal farming films

Carbon Electrodes in the Making

By A. R. Surface

A NEW plant for making amorphous carbon electrodes, regarded by many as the most modern and complete plant of the kind in existence, has just been completed and put in operation at Niagara Falls, N. Y.

This new plant is a direct outgrowth of the war. To meet the very heavy expansion in the manufacture of electric steel and most ferroalloys during the latter part of the war, the demand for electrodes became so great that a marked scarcity was the result. To avoid the shutting down of some plants, many electrodes had to be shipped by express. Not only are electrodes as necessary in the making of steel or ferroalloys as electricity itself, but the field of application is widening for they are now employed in plants producing carbide, carborundum, aluminous abrasives, aluminum, silicon, magnesium and other metals and by certain chemical companies.



Unloading the raw material—petroleum coke—at the carbon electrode plant

The two important features which characterize this new plant are the handling of most of the raw material by gravity or mechanical lifting apparatus; and the calcining of the coal and cokes by electricity.

The raw materials used in making carbon electrodes are anthracite coal, coke, petroleum coke, retort carbon, hard and soft pitch, tar and oil. The first four of these materials are brought in by track in cars, and by means of a track hopper and apron conveyor they are fed into a large crusher. From this the crushed material is transferred to the calcining building on a large supercarrier. The tunnel in which this conveyor or carrier operates is so constructed that a second track hopper with motors, crushers, etc., can be installed. By means of belt conveyors the raw material is placed in bunkers in the calcining building.

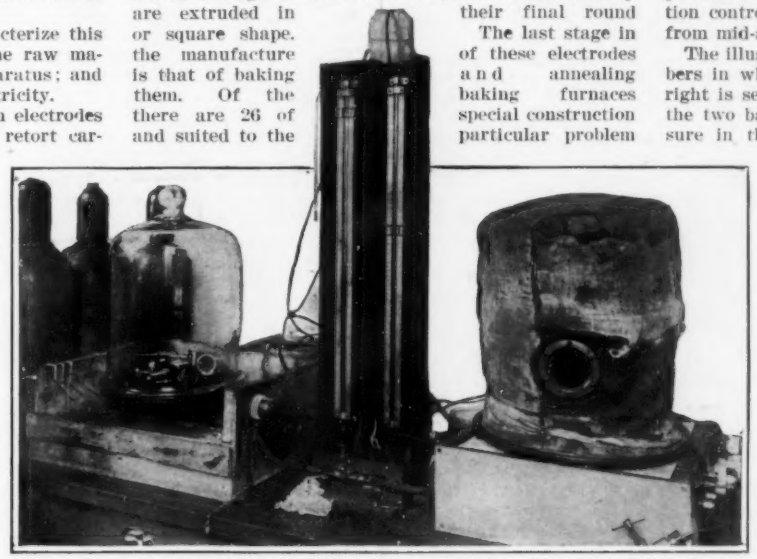
In specially designed electric furnaces the crushed coal or cokes are electrically calcined, thus reducing them as nearly as possible to the condition under which they are to function as electrodes. This is one marked advantage claimed for electric calcination. It is also said that even certain portions of the ash in the coal or cokes are removed, so high is the temperature.

The next step in the process is the grinding of the raw materials to the proper fineness. This is done in a separate building near the calcining department, to which the calcined coal and cokes are brought by means of elevators and belt conveyors. After the grinding is completed the various materials are elevated to the top of the mixer building by various blowing or elevating conveyors. There, 100 feet above the ground, they are screened and then stored in a series of tanks arranged systematically for the various materials.

The proper mixing of the various raw materials is an extremely important part of the process. From the tanks in which the ground and screened materials are stored, the various ingredients for the carbon electrodes of certain specifications are fed by gravity into weighing cars. From these the materials then fall into specially designed mixing machines on a still lower level of this building where the various components are intimately mixed. The resulting product is then molded into lumps of carbon with its binding material, and resembles a large cheese. This is carried on in the cheese pit below.

The next step in the process is the transformation of this crude plastic material into the form of an electrode in practically the same shape in which it is to be used. A massive 3,000-ton hydraulic press of the company's own design is used for this purpose. In this machine the various cheese-like masses of prepared carbon are forced through dies of various sizes from which they are extruded in their final round or square shape.

The last stage in the manufacture of these electrodes is that of baking and annealing them. Of the baking furnaces there are 26 of special construction and suited to the particular problem in hand. All of these furnances are built below the floor level and are heat-insulated on the sides and ends. They are all fired by producer gas from the gas-producer building close by. They operate on the ring principle. The green electrodes are placed in saggers, using coke, coal or sand as packing material. These are then placed in the various compartments of the furnaces and buried in the insulation.



Laboratory equipment for testing the oxygen apparatus of the high-flying airman

Casting platforms of a plant which turns out all kinds of cast concrete products

High Flying in the Laboratory

By S. R. Winters

DISTINGUISHED as the first equipment of its sort in existence, the oxygen testing apparatus shown in the accompanying illustration has been devised by the United States Bureau of Standards in facilitating the use of oxygen when airplanes attain extreme altitudes. The liberal use of this essential component of life-sustaining elements is advisable when a flying machine exceeds a height of 15,000 feet.

The delivery of the oxygen is controlled by an automatic device, the testing of its performance in regulating the flow of gas being impossible during the flight. Consequently, the Government has duplicated the conditions of flight at high altitudes, in the laboratory, the apparatus being a model for wholesale production by commercial enterprises. Decreased pressure, temperature as low as minus 40 to 45 degrees C., and vibration control are the analogous conditions transplanted from mid-air to the laboraory.

The illustration shows two of the low pressure chambers in which the pressure is varied at will. To the right is seen the one for low temperature work, while the two barometers are designed to indicate the pressure in the chambers. The chamber, shown at the left of the illustration, is where the room temperature calibration tests are conducted.

The airplane oxygen equipment is placed in the chambers and the pressure about the apparatus reduced to that corresponding to 30,000 or 40,000 feet in flying altitudes. Gradually, the pressure is restored to normal atmospheric conditions at ground level, this being accomplished by the delivery of oxygen from the high pressure tank, through the instrument, into the chamber. The rate of change in pressure is indicated by the barometers with the aid of a stop watch. This, together with the volume of the bell jar and the temperature of the gas inside, furnishes the essential data for computing the rate of delivery of oxygen by the instrument at varying altitudes during flight.

Soap for Petrol Tank Repairs

ALL motorists should carry with them a little soap for use in gasoline tank repairs. It is not generally known that soap does not dissolve in gasoline and thus makes an excellent medium for the filling in of holes. A good amount plastered over an opening will keep the situation tight for a long while. Soap may also be rubbed on the thread of the union nut.

Where Concrete Things Are Cast

By G. Orb

LOCATED at Morrisville, Pa., is an immense plant for molding and casting concrete column, roof-girders, beams, telegraph poles, bridge slabs, fence posts and the like. Not only is this plant of interest because of the character and size of the operations conducted here, but it possesses some unique features as well. For example, between each two casting platforms is a pair of industrial service tracks. These casting platforms are each 60 feet wide and 450 feet long, 6 inches above the rail level.

Since much of the work has to be done in freezing weather, it becomes necessary to protect the fresh concrete on these platforms from freezing. This is accomplished by rolling a portable shed (60 feet wide by 100 feet long) over the fresh concrete and leaving it there until the concrete is beyond danger, then rolling the shed over another portion of the platform to protect fresh work.

Among the Mountains of Western Canada

Famous Valleys and Peaks of the Canadian Rockies Described By a Mountaineer

By LeRoy Jeffers, F.R.G.S., Secretary Bureau Associated Mountaineering Clubs of North America

Photo by F. N. Waterman

Ascending the Mitre, Paradise Valley

Photo by Byron Harmon

Takakkaw Fall, Yoho Valley

AFTER traversing Mount Mansfield, the highest of the Green Mountains of Vermont, in a storm, we journeyed to Field in the Canadian Rockies where we started on the long climb over Burgess Pass to the Yoho Valley. At first our way lay through the forest with enchanting glimpses of Mounts Stephen, Cathedral and Vaux; then across rich flower slopes glowing with yellow, red, white and purple. From the summit of the pass we climbed toward the perpendicular cliffs of Mt. Burgess rising 4,000 feet above the still, green waters of Emerald Lake. Across the valley we viewed the hanging glaciers of the President Range. Following the slope of Mt. Wapta, we passed the mine where Dr. and Mrs. Walcott of the Smithsonian Institution were finding fossils of some of the earliest forms of life, and finally reached the camp of the Alpine Club of Canada at Yoho Lake.

Down the winding trail we wandered into the Yoho Valley, lingering often beneath the cathedral spires of the spruces while we watched the great Takakkaw Fall hurling itself in utter abandon for more than a thousand feet into the depths of the valley. It is slowly wearing its way into the heart of the mountain, and vast converging walls of rock rise on either side. Born beneath the ice of the Day Glacier, the Takakkaw foams through its hidden canyon, leaping to view as it plunges downward to a ledge that hurls the torrent outward with the force of a geyser. From this mass of water a multitude of feathery comets emerge for their wild flight to the valley. Like rockets they race with one another, wearing a veil of mist in which they finally disappear. Seething along the edges of the fall the mist streams upward, or is whirled about by the wind and irised by the sunshine.

The road already extending from Field to the Takakkaw will be continued to the Yoho Glacier at the head of the valley, but as yet one may enjoy the solitude of the trail through the forest. Turning to the right where it forks, we reached the brink of the Yoho Canyon, a wild gorge where the river has cut a tortuous passage through steeply tilted strata. Madly the water foams, leaping from wall to wall and filling the air with the voice of its incessant battle. A little beyond is Laughing Fall, where the Little Yoho, alive with energy, bursts through a narrow opening in the cliffs and hurls itself to the rocks below, shooting forth clouds of cooling spray. Finally we work our way down the moraine of the Yoho Glacier to the ice cave from which the Yoho River once flowed. In common with nearly all glaciers, this one is receding, having withdrawn about 100 feet during the last year. Much of the river has sought a new channel beneath the ice, and it gushes forth high up on the eastern slope of the glacier, where it has cut a new canyon that prevents the ascent of Balfour Pass by way of Diableret Fall. The landscape is rich with color, from the brilliant flowers that wander over the moraine to the deep blue and green of the ice in the cool shadow of the cave. The surrounding cliffs of light gray and brown are painted with bright orange and violet.

Retracing our steps, we followed up Twin Falls Creek to a very deep and narrow gorge down which the water rushes with great velocity. At Twin Falls the river takes a double plunge over sheer cliffs hundreds of feet in height. Near the base of the larger fall a jutting rock causes it to boil upward like a fountain. Following the high trail we finally reached camp on the Little Yoho. Years ago I had taken the long trudge up the glacier to the summit of the President 10,287 feet where a snow storm had hidden the view. Now I was to climb Mt. Marpole 9,822 feet whose northern arete is one of the most interesting rock climbs in the mountains. The morning was exceptionally hot; but my Swiss guide, with lively memories of former rapid climbs, led me up the valley and over the moraines without pause for five miles. Then we ascended the glacier, roped to cross the snow fields, and left our axes where we could recover them on our return. At last we were face to face with dark, forbidding cliffs that towered over 1,500 feet above us. So broken and disintegrated is the rock that we could hardly be sure of our hand and foot holds. Much of it is weathered so sharply that it could easily cut our hands. Acrobatic work is continuously provided, but great caution must be used to avoid dislodging rocks that may fall upon the heads of those who follow on the rope. Twice my hand found itself in the line of fire from stones which dropped fifteen or twenty feet from the guide who was concealed from my view. Sometimes the rope itself may start a miniature avalanche which one has neither time nor room to avoid. Often the rope is only a moral protection; for, if one should slip, he would easily fall far enough for fatal consequences before exhausting the slack of the rope; while the weight of one who suddenly falls will pull backward the best of climbers if he

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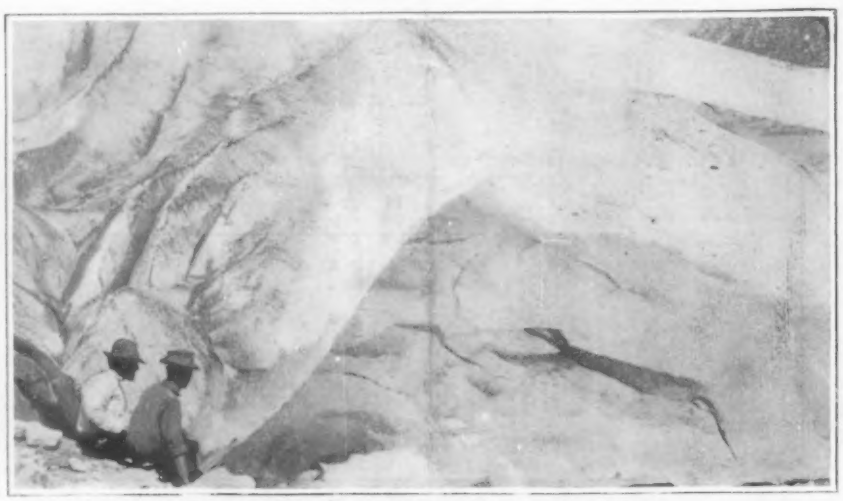


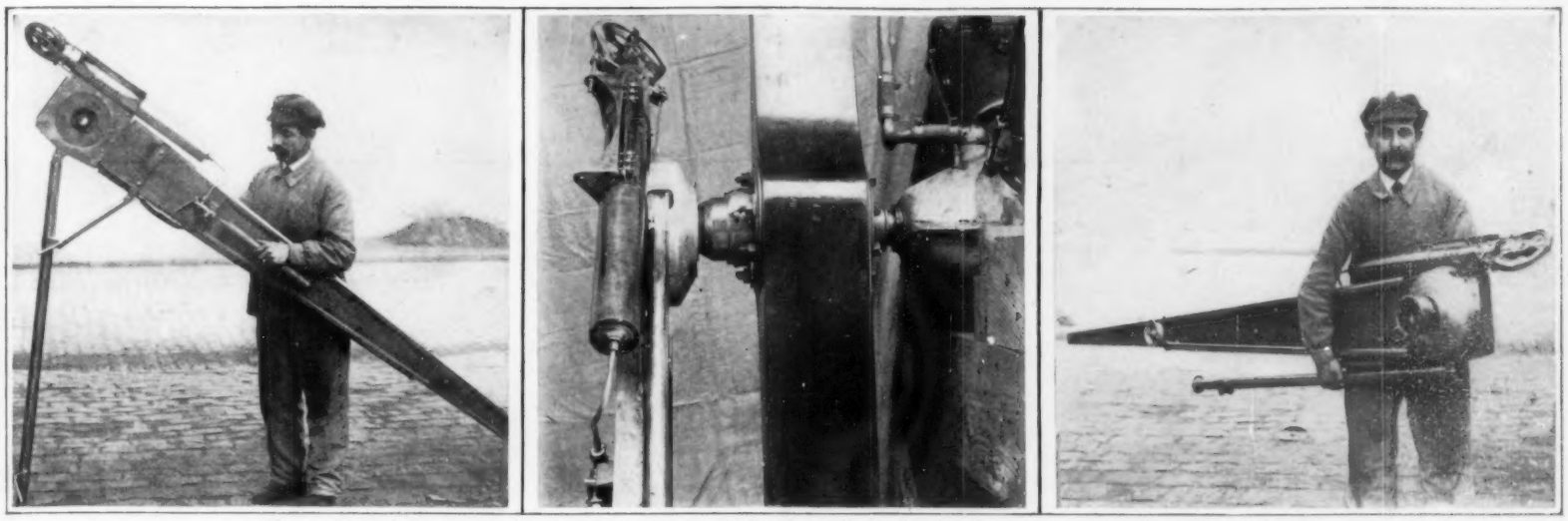
Ice cave, Yoho Glacier, where the Yoho River is born

Photo by F. N. Waterman

Head of a chimney, Pinnacle Peak

Photo by Byron Harmon

Twin Falls, Yoho Valley



Three views of the pneumatic cranking device for airplane propellers, showing its extreme portability and application

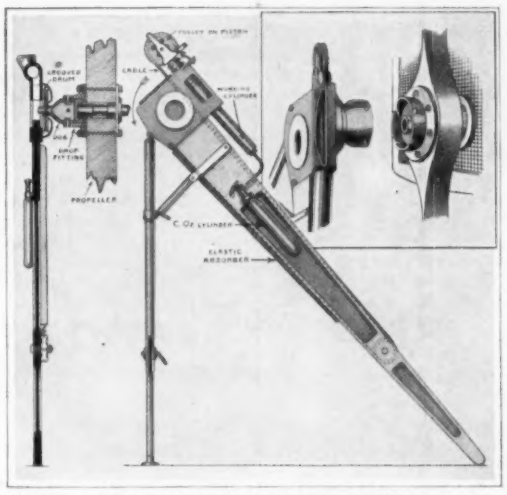
Cranking Airplane Propellers With a Flask of Air

EVERYONE in or out of aviation is ready to admit that the present method of hand-cranking the propeller is primitive and certainly dangerous. Yet for want of suitable cranking equipment this crude practice has persisted despite many attempts to introduce some mechanical means. Some attempts have been along the line of a self-starter for the airplane engine, following automobile practice; but even at this late date airplane designers are not anxious to add anywhere from 40 to 100 pounds of relatively useless weight to their power plant. The preference has been given to portable propeller swingers, which could be carried about the airdrome and used for cranking any airplane.

One of the most successful airplane propeller swingers is that invented by a Frenchman, M. Odier, and illustrated in the accompanying views and drawing. In the first place, the weight of this propeller swinger is by no means excessive, so that one man can carry it about with ease. Furthermore, it is compact and safe to handle.

Briefly, the Odier starter consists simply of a bipod carrying at its upper end a long steel cylinder and piston.

Attached to the extremity of the piston, which projects outside the cylinder, is a pulley over which a cable is passed, having one end fastened to the cylinder and the other end wound four times round a grooved drum and then secured to an elastic absorber. The grooved drum is mounted on a short shaft having a bell-shaped extremity on which four projections are placed symmetrically around the periphery in such a way that they can be made to engage with sloping recesses in a standard fitting mounted on the boss of the propeller or tractor screw. The mechanism is actuated by turning a valve which releases the contents of a cask of carbon dioxide gas into the working cylinder.—By *George Gaulois.*



Mechanical details of the airplane propeller swinger, invented by a Frenchman

The Topical Lamp Post

By Howard C. Kegley

ELECTRIC signs have long been used to set forth the cardinal virtues of some of our American cities, but it took southern California to discover the advertising value of street lighting systems. No less than six of her cities have already spread their fair fame broadcast by installing street lamp posts with designs symbolic of their greatest historic tradition.

Among the cities which have already adopted the idea of installing symbolic street lamp posts are Los Angeles, Riverside, San Bernardino, Seal Beach, Alhambra and San Gabriel. The idea is so striking that Chambers of Commerce in other California cities are already advocating similar plans in order to give their respective communities more publicity.

Since the King's Highway, or El Camino Real, the footpath of the Mission Fathers, reaches through many important cities of southern California, the Mission Bell affords one of the best opportunities for giving publicity to some of the towns which now enjoy heavy tourist patronage during the winter season. Thus Riverside has accentuated the Mission feature of her community spirit by installing a rough concrete street lamp post in the form of a chapel bell tower with three Mission bells hung in a triangle, and a cross at the top of the design. This clever conception is to be found on all the principal streets of the city, and it is decidedly in harmony with the Spanish style of architecture which long ago impressed itself strongly upon the traveler.

Second in importance from the standpoint of symbolic value is the Arrowhead street lamp post at San Bernardino. One of this city's greatest assets from the publicity standpoint is a gigantic stone arrowhead on the mountainside about eight miles distant, which can easily be seen from trains upon their arrival in the city. This arrowhead has a romantic Indian legend back of it, and because of its close proximity a mineral spring in the San Bernardino mountains was named Arrowhead Springs, and a flourishing health resort eventually sprang up there. Two years ago the city of San Bernardino adopted the arrowhead as a design for its street lamp posts, and these are now the subject of much discussion among travelers passing through the city.

Another city which has used symbolic street lamp posts to capitalize its greatest advertising feature is Seal Beach, a short distance from Los Angeles. This seaside resort was so named because in the neighborhood of 200 large seals have long made their home in a little cove a short distance up the beach. These were the objects of much curiosity, and they attracted so

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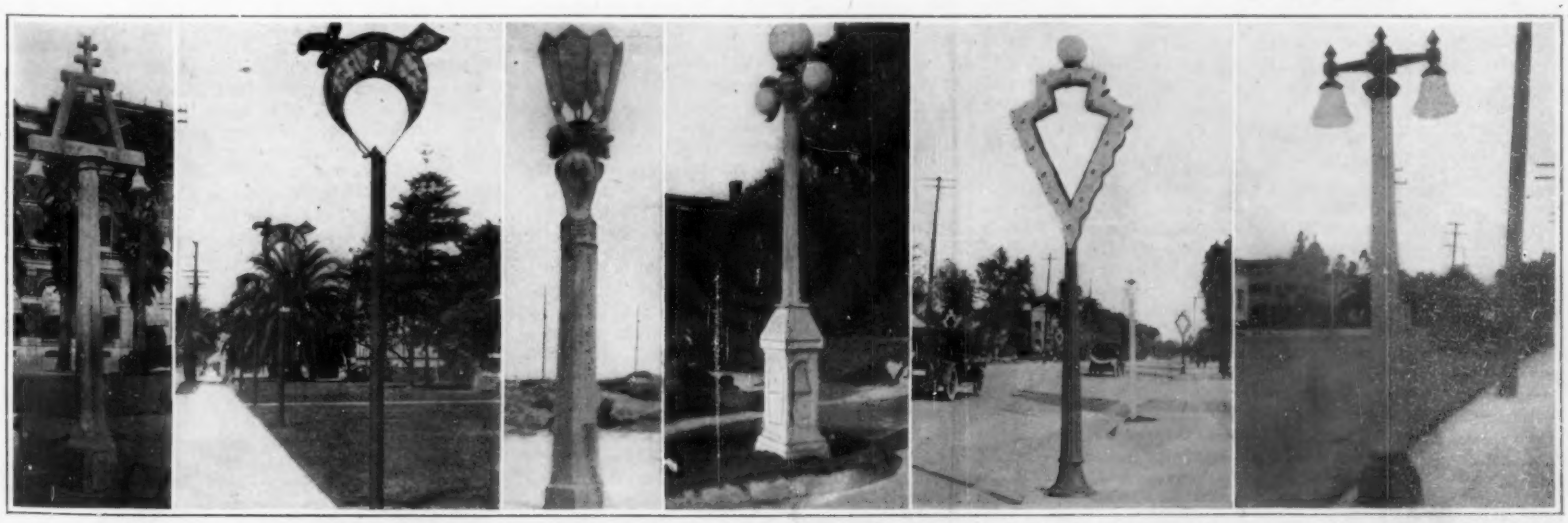


From left to right : These posts are from Riverside, Los Angeles, Seal Beach, Alhambra, San Bernardino, and San Gabriel. Each design in some way incorporates a feature of the town's history or present points of interest

Symbolic lamp posts of California towns and cities

National Life Insurance on the Endowment Plan

Universal Training—What It Is and Do We Want It?

By Tompkins McIlvaine, Chairman, Military Committee, Training Camps Association

WOODROW WILSON and Leonard Wood have come to an agreement on one subject, Universal Training. They reached this agreement February 7th last. Everyone knows that General Wood has always advocated Universal Training. On February 7th, 1920, the President wrote advising the Democratic caucus of the House against committing itself to opposition to Universal Training, adding:

"The present disturbed state of the world does not permit such sureness with regard to America's obligations as to allow us lightly to decide upon this great question upon purely military grounds, while the demonstrated advantage to the country which came from military service in the war plainly suggests that in the national interest, quite apart from military considerations, a moderate and carefully conducted course of military training may have the highest possible advantages."

The Military Committees of the Senate and the House have endorsed Universal Training and the Senate Committee has reported a Universal Training bill (Senate Bill No. 3,792). This Universal Training bill will shortly come to a vote and, it is hoped, will be passed. Thereupon this bill and the House bill for Army reorganization (a sub-committee has been appointed by the House to make a special study of Universal Training) will be referred to conferees.

An overwhelming majority of the five million veterans who have in any way expressed themselves, and their association—The American Legion—favor Universal Training. Patriotic associations, chambers of commerce, distinguished individuals, and others also endorse the Senate Bill. The Secretary of War says:

"In commenting upon so large and generally excellent piece of legislation I hardly know where to begin. . . . It is the most statesmanlike attempt to reorganize the army with which I have any acquaintance."

Universal Training means: First, that everyone is to be under the same obligation to do his share in defending the country as he is to perform any other obligation of a citizen; the call to be imposed with due consideration for social and economic conditions; that the unmarried and younger shall be called first; that essential occupations shall be disturbed as little as possible, and that everyone called shall be assigned to the kind of duty which he is best suited to perform.

Second: That when a citizen is under an obligation to perform a duty, the Government is under a corresponding obligation to instruct him, in advance, how to perform that duty efficiently and with the minimum of risk.

Third: That we will not put ourselves in the dilemma of either confiding our national safety to an insufficient force of professional soldiers, or of fastening upon ourselves the militaristic and costly policy of a huge standing army.

Now how does the Senate bill, endorsed by Republicans and Democrats provide for Universal Training?

First: By establishing the principle that the professional army is always to be the *minimum* necessary for overseas garrisons, peace time, interior guard duty, etc.

Second: By creating a citizen army through the training of every young man for a period of four months between the ages of eighteen and twenty-one, such training to be immediately preceded, in the case of the foreigner and the illiterate, by two months' extra educational training. Of a million boys who become twenty-one in any year, 50,000 cannot speak our language, and 150,000 cannot read or write any language intelligently.

As a preliminary to training, every boy at seventeen is to be classified by a *local* board of *civilians* as fit for combatant *or non*-combatant training. The whole Universal Training system (including the reorganized National Guard of the United States) is to be *organized by localities*. All officers and non-commissioned officers are to be volunteers *chosen from the ranks* on the competitive principle, and after progressive training to fit them for the successive steps in promotion. The French idea of the parental relationship between officer and man will be the keynote of discipine.

The graduates of the Training Camps are to be assigned to reserve units of the citizen army according to their *home localities* and States. Each graduate is to be called out twice during a period of five years for maneuvers lasting two weeks. The smaller units will be organized into larger units, including divisons, corps and armies, the staffs of which will be permanently maintained in order to give experience in higher command and to provide the machinery for annual training maneuvers or prompt mobilization in an emergency. The Senate bill expressly provides that no service as distinguished from training can be required in time of peace.

As it is neither possible nor desirable to devote the whole of each day's time in the camps to military drill and study, it is provided that instruction shall also be given in physical training, personal hygiene, American history and in trades and scientific agriculture. All officer grades are opened to the graduates of the Camps. The privilege of becoming a Regular Reserve Officer is also given to all who served in the war or in the National Guard or Militia.

Third: No further training is required of the veterans; but they may become charter members of the citizen army by volunteering to act as instructors and leaders. Provision is made that the designations and flags of the units that served in the war shall be preserved.

Fourth: The moral and physical health of the young men is assured. It is intended that civilian experts in physical training, sanitation, social hygiene, preventive medicine and surgery shall be attached to the War Department to advise regarding matters pertaining to the Universal Training system.

Fifth: The National Guard is to be reorganized into the National Guard of the United States thereby becoming an integral part of the citizen army. While the Guard is to be composed of local residents, it is to be primarily a Federal force, but the officers—appointed in time of peace on recommendation of the Governor—and the men are to assume a dual obligation which will permit the Guard units within any State to be called upon by the State. When so called on they will be wholly under State control. In order to make the whole system as flexible as possible in suiting the inclinations of individuals and the requirements of their occupations, the option is given to every boy to take his training therein. This will take care of those boys who for one reason or another cannot spare the four continuous months required by the Training Camps.

Sixth: The War Department is to be reorganized: by giving to every arm and branch its own chief for administrative purposes; by reorganizing the general staff and creating a general staff eligibility list from officers now or hereafter qualified, and providing that all general staff officers must be chosen therefrom; by dividing the general staff into two parts, the War Department General Staff and the General Staff with troops; by confining the War Department General Staff to its proper function of advising the Secretary of War regarding military policy and plans and giving aid and assistance to him and his executive and coördinating agent the Chief of Staff; by providing for the creation and maintenance of division, corps and army staffs; by requiring liberal civilian representation (including physicians) on the sections of the General Staff concerned with the citizen army system; and by opening the general staff to reserve officers. The reserve officers' training corps as existing in most colleges is to be fully maintained and developed.

Regular officers are to be classified annually by a board of general officers on their records into three grades—A, those qualified for immediate promotion; B, those qualified to hold present rank; and C, those to be retired; this in order to eliminate the unfit and to provide an incentive for all to do good work and to keep up with their profession.

Definite estimates of the cost of the regular army cannot, for a variety of reasons, now be made, but the figures run up to approximately $2,000 an individual a year.

When fully reorganized and established the National Guard—which heretofore has never maintained a strength of more than 100,000—will cost the Federal Government approximately $300 an individual a year.

Apart from the instruction and equipment and the original cost of camp sites (already owned by the Government), the expense of a Universal Training system, such as the four months provided by the Senate bill, including the extra two months' educational period for the foreigner and illiterate, would average about $200 a year a man trained. As it is estimated that there would be available each year for training about 640,000 men, this means $128,000,000 a year. It would not, however, be advisable to call up any boys before 1922.

General March drew a bill which was sent to Congress providing for a professional army of 576,000. Even this huge professional force would be wholly inadequate to meet the exigencies of a modern war, and its cost would be prohibitive. With Universal Training the present authorized strength of the regular army (about 225,000) would be sufficient.

On some such plan as the Senate bill, an adequate system of National defense based on Universal Training, would cost for the coming five years, for the regular army, National Guard and citizen army, not more than $500,000,000 to $600,000,000 a year, or little more than half the cost of the professional army system recommended by General March.

Will such a system of Universal Training lead to militarism, or will it lead to democracy and National safety? Will the farmer lose anything by his boy putting in four of his slack months at Government expense, at a training camp which must be in the country and not in a city? and may not the eyes of many a city-bred boy who has never seen the country be opened to the benefits and opportunities of country life? Need any Southerner fear that the negro question will be further complicated by Universal Training. Is it not the negro who will most profit by vocational training?

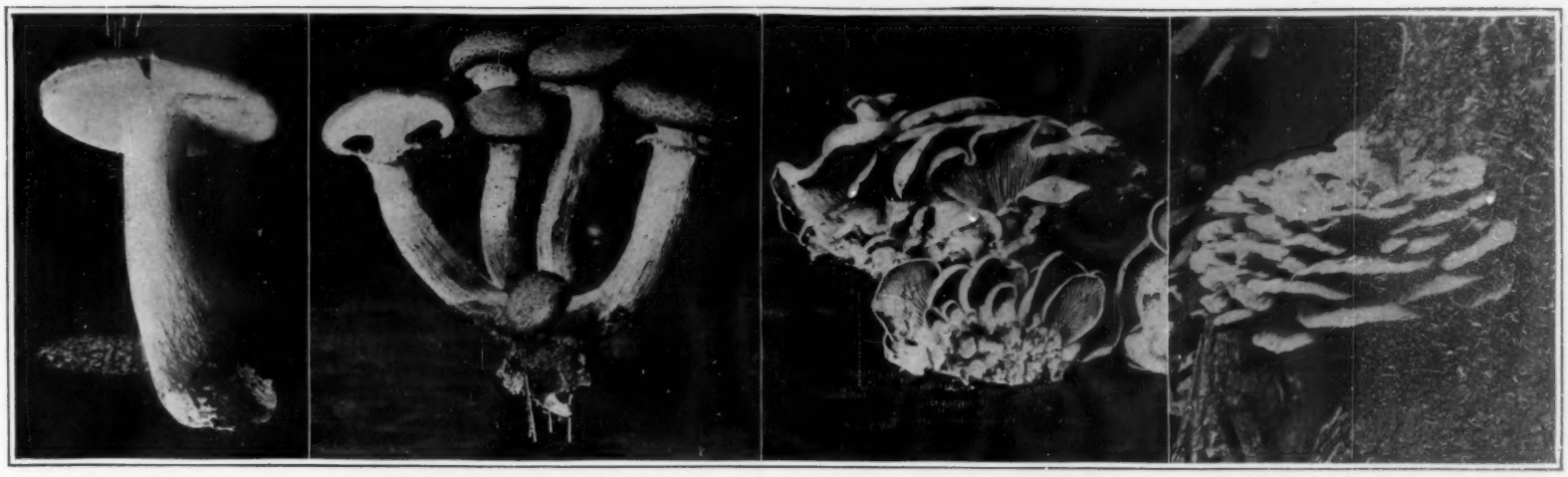
Is there not far more danger of aggravatng the negro question through such hasty and ill-considered action as was taken by an unprepared country after the outbreak of the war, than through this peace-time system of careful and local classification of all citizens for the kind of training—combatant or non-combatant—for which they are best suited?

Under the qualification tests the negro officer question is a bugaboo. No man, whatever his color, can become or remain an officer who is not highly mentally developed, balanced and trained, and who does not excel in leadership of men and in the military art.

Will any boy, whatever his education or lack of education, and however occupied or idle, not be the better for spending a few months engaged in a great patriotic purpose, in association on the basis of equality and fraternity with other boys of his own age from every walk of life? Will not the association tend to break down social and industrial antagonisms and tend to Americanization and national solidarity? And, finally, will not the boy himself be a better man morally, physically and mentally, and will not the few months spent result in an increased efficiency that will far more than offset any temporary interruption of his ordinary occupation? The veteran ought to know, and however hard his individual experience, he says—Yes. What, gentle reader, do you say?

Congress will soon have to vote. The Senators and Congressmen want to know what the folks at home think. Let your Senators and Congressmen hear from you according to your convictions.

WE commend to our readers, for a very careful study, the plan for Universal Training which is outlined by Mr. McIlvaine in the present article. We believe that an unprejudiced reading will bring the conviction that this plan for national insurance is peculiarly fitted to the spirit and traditions of the American people. It is in its very essence equitable and democratic, and, while it enlists the whole potential manpower of the country for the purposes of national security and defense, it accomplishes this end with a minimum of interference with our industrial and social life.—THE EDITOR.



Ceriomyces crossus — Cluster of Armillaria putrida — Panellus stypticus — Lactiporus sulphureus on ash tree

A collection of fungi that give forth a luminescense that is truly startling

Plant Growths that Shed Light

By W. A. Murrill

THE phenomenon of phosphorescence, or luminescence, in living organisms has long been known and wondered at, but there remains much to be learned about the entire subject. The light-bearing fishes of the deep sea, the "sparkling" waves at the sides of a ship on a dark night, the fire-fly and glow-worm, and luminous bacteria occurring on decaying fish, cabbage, etc., are well known. Molisch's bacterial lamp designed for mines and powder magazines was an attempt to put this process of slow oxidation to some practical use.

In animals, the light is usually brief and intermittent, while certain fungi may give off light continuously for days, weeks, or even months, so long as the light-giving cells are uninjured and active and water is present. This light-giving power is recognized as useful to animals, but is probably without biological significance in plants. One can hardly believe that the spores of certain fungi, for example, are distributed to any great extent by the moths and fireflies that happen to be attracted by the weird light emanating from their spore-bearing surfaces.

In some fungi, the power of luminescence is confined to the active cells of the mycelium. This is true in the case of the honey agaric, which inhabits old stumps and often causes them to glow on dark nights. While the rhizomorphs of this species are covered with active hyphae they are luminous, but when they form a cuticle and enter the resting period the luminosity

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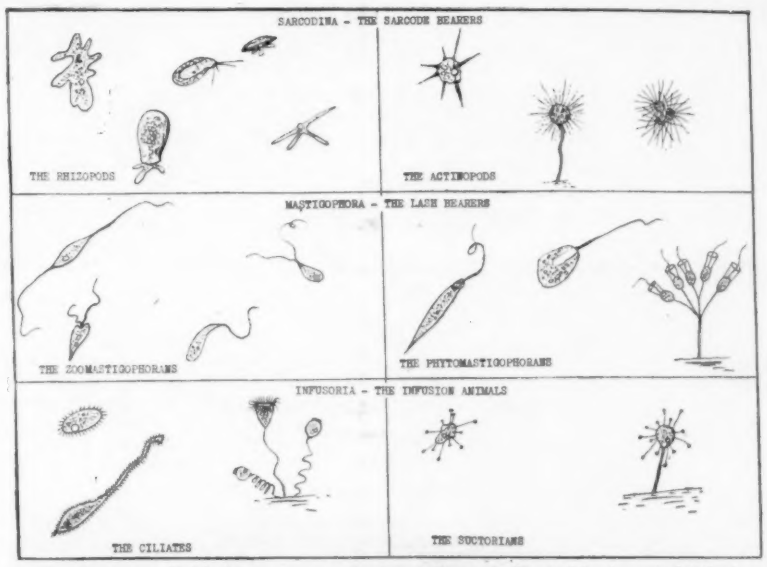


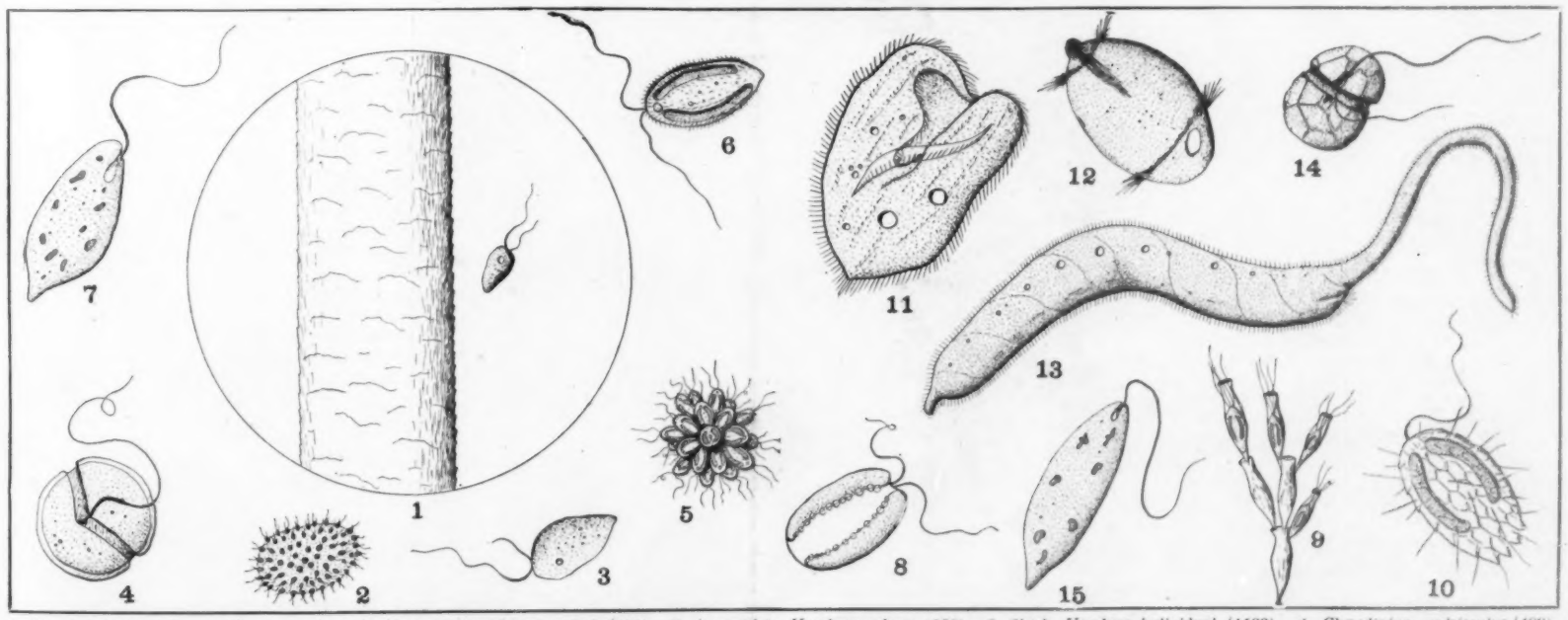
The Protozoa, divided into groups (horizontally, as indicated by inserted titles) and classes (Class I at the left, Class II at the right)

Tiny Creatures That Make Bad Water

By Leon Augustus Hausman, Ph. D.

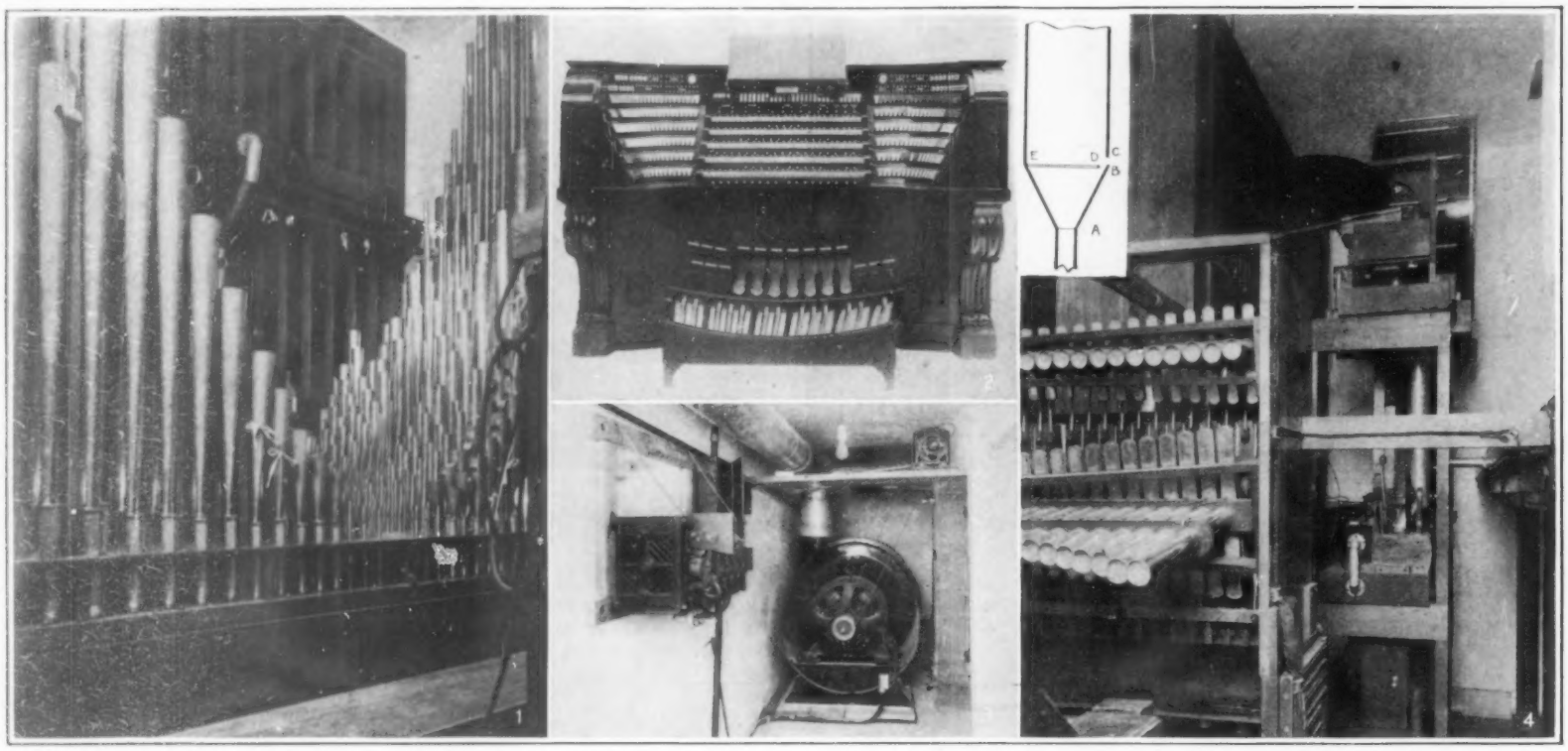
MUNICIPAL water supplies which are derived from surface sources and stored for use in large reservoirs, frequently develop, specially during the early months of spring and summer, various so-called "fishy" and other disagreeable odors and tastes, which render the water unpalatable, and often almost entirely unfit for use. These objectionable odors and tastes are due chiefly, not to the decomposition of fish, or the decay of the remains of the higher aquatic plants, as is commonly believed, but to the presence in the central reservoir of numerous micro-organisms. The minute offenders are certain species of algae, or unicellular plants, and protozoa, or unicellular animals. Since the matter of water pollution from micro-organisms is one of large importance to water-works superintendents, as well as to the public in general, considerable study has been made by botanists and zoologists of various troublesome forms. The results of such study have been applied, with varying degrees of success, to the eradication of the evil. Methods of destroying many of these minute forms by chemical means have been devised, and of removing their characteristic unpleasant odors and tastes by various forms of filtration and aeration of the affected water.

(Continued on page 446)



1. Single individual from a *Uroglena* colony, beside a portion of human hair (500). 2. A complete *Uroglena* colony (150). 3. Single *Uroglena* individual (1500). 4. *Glenodinium pulvisculus* (400). 5. *Synura uvella* colony (165). 6. Single individual from *Synura uvella* colony (750). 7. *Euglena sanguinea* (375). 8. *Cryptomonas ovata* (375). 9. *Dinobryon sertularia* (560). 10. *Mallomonas sp.* (1300). 11. *Bursaria truncatella* (75). 12. *Didinium nasutum* (375). 13. *Dileptus gigas* (200). 14. *Peridinium tabulatum* (375). 15. *Euglena haematodes* (350).

Some of the microscopic creatures that cause the offensive odors noted in water of questionable origin. The figure in parenthesis after each caption gives the magnification of the corresponding drawing



1. A portion of the forest of pipes in the Denver organ. 2. The console of the Philadelphia instrument, with its five banks of keys. 3. Part of the motor equipment of the Denver organ. 4. Another view behind the scenes in the Denver organ; *in the insert*, a diagrammatic representation of the principle on which the "mouth pipe" works

Some representative views of the great organs in Philadelphia and Denver

Two Great Organs

Some Interesting Details of the Philadelphia and Denver Instruments

By J. F. Springer

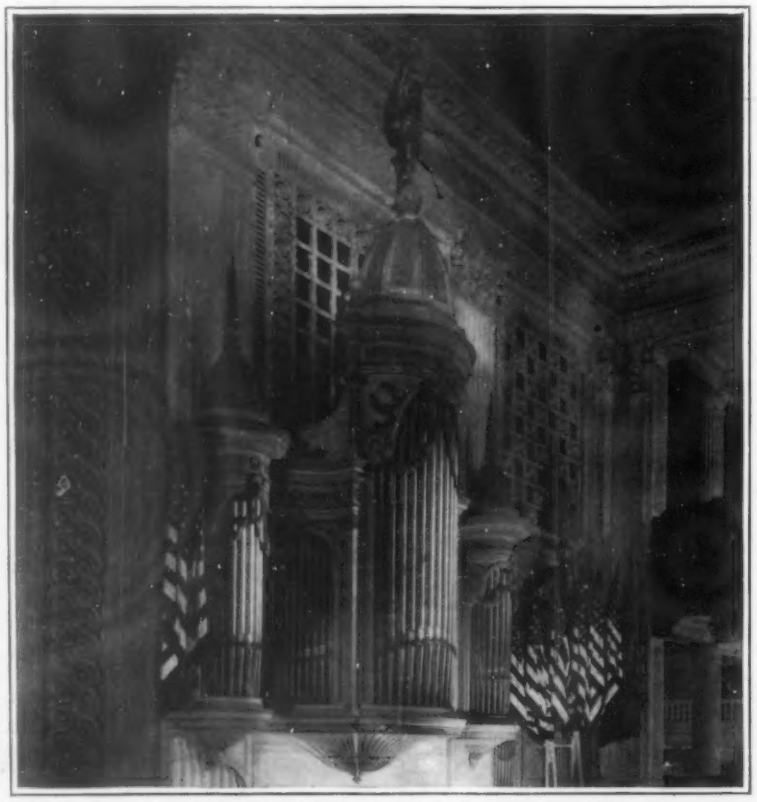
THE greatest and grandest of all musical instruments is, undoubtedly, the organ. This being the case, Americans may well be proud that in the United States are the two instruments which probably stand at the head of all that have so far been built since the first organs were constructed.

In a great department store in Philadelphia is a gigantic instrument having 17,954 pipes and as many as 232 speaking stops. In fact, this big affair comprises eight different organs—namely, a great organ, a swell organ, a choir organ, a solo organ, an ethereal organ, an echo organ, a pedal organ and finally a chorus organ. The smallest number of pipes occurs in the chorus organ (732) and the largest in the swell organ (4,346). Controlling the 17,954 pipes are six keyboards—five manuals and one set of pedals. There are only a few other instruments in the world with as many as five manuals. They are in Breslau, Hamburg, London, Liverpool, Sydney (Australia), etc.

The operating device from which the organ is played and which contains the manuals, the set of pedals, and the stop handles, is called the console. In the present case, the main console weighs one ton and controls, in addition to the organ itself, a piano, two sets of chimes (major and minor), one set of gongs and a harp. These may each and all be played from the complex keyboard of the console. Of special note is the harp which is played not by striking the strings, but by plucking them after the manner of a hand performer. This type of harp is a new invention, and is, presumably, present only in this organ. The great instrument is distributed somewhat over the building, but if all the parts were gathered together and weighed the weight would be 375,000 pounds.

Originally, this organ was set up for exhibition at the St. Louis Exposition in 1905. The gold medal was awarded to it. But the big organ which then won the gold medal is only a part of the present instrument. The organ as now developed is 80 per cent greater than the original.

Some may think that the visible metal pipes usually seen above the keyboard of a pipe organ constitute the full complement. But this is seldom or never the case. In the present case, the visible display of piping is more or less impressive, but the real instrument is not on parade. The pipes of a big organ like this one will be, some of them, of wood, and some of them, of metal. They will be big and little. The smallest pipe is a little fellow which may be held in the palm of one's hand. The largest pipes are two in number, both 32 feet in length. One belongs to the pedal organ and the other to the open Diapason register. No organ pipes excelling these in size and power have, it is believed, ever been constructed. The 32-foot open Diapason contains over 1,000 board feet of 3-inch sugar pine and weighs 1,735 pounds. It is some pipe. But this is not the very longest pipe; that distinction belongs to a metal pipe 37¾ feet long and 17 inches in diameter.



The show pipes of the Philadelphia organ as they are seen from the front

The proper housing of nearly 18,000 separate pipes of such various sizes and forms is something of a problem. Back of the organ screen the greatest part of the pipes are set up in a room 50 feet high and 30 feet deep. The original organ, less than 60 per cent of the present instrument, required 13 freight cars to accommodate it while in transit from St. Louis to Philadelphia.

Before going further, it may be well to get before us some fundamental items of information as to the modern organ. The standard sounds are made by or in connection with two classes of tubes—the mouth pipe and the reed pipe. In a mouth pipe, the musical note is generated by the vibration of the contained column of air. The pitch is dependent upon the effective length of the tube and upon nothing else. The diameter of the tube, its cross-section size, the material of which it is made, all have nothing to do with pitch. The tube may not even be straight but curved. But effective length does regulate the pitch. A representative mouth pipe is shown diagramatically in the vertical section above. The compressed air enters through the opening A and fills the pyramidal or

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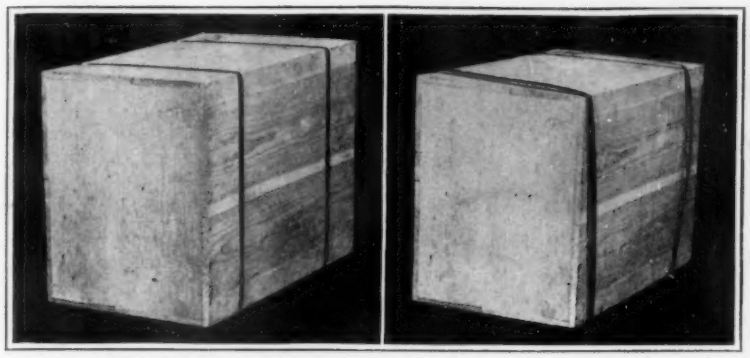


This box was bound up with iron straps so tightly that the straps cut into the wood; but see what the sun did to it!

When Packing Boxes Shrink

PACKING boxes often shrink, with unfortunate consequences at times. The accompanying illustrations serve to show the loosening of box strapping due to excessive shrinkage.

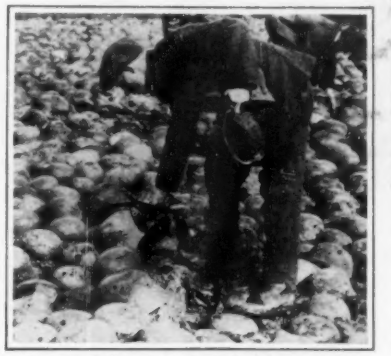
It is a well-known fact that wood shrinks upon drying, but it is nevertheless frequently overlooked. We find this especially true in certain branches of the packing box industry, mainly in those branches where boxes are liable to be made up far in advance of actual need and then stored, and in many miscellaneous instances where the art of boxing and crating is not thoroughly understood. The shrinkage of wood causes not only the loosening of the straps, but also the loosening of the nails. This latter feature is especially troublesome where the boxes are made up out of green wood quite a long time before they are used. Of course, it is not always the fault of the boxmaker that the wood in boxes shrinks and causes trouble. The conditions of storage and handling after the box has been packed are frequently responsible; thus boxes that have been stored in a fairly damp place for several months and are then transferred to a warm, dry place are sure to shrink appreciably and may cause considerable trouble.—By *S. R. Winters.*

Fiddling the Saw for Music

THE conventional saw has recently appeared in a new rôle, namely, as a musical instrument. Indeed, one of the leading novelties of a current New York musical revue is the musical carpenter who uses his saw as a violin, as shown in the accompanying illustration.

After protracted experimentation and untiring practice, Sam Moore of New York City, has succeeded in getting very agreeable music from the ordinary carpenter's saw. He holds the saw handle between his legs, as shown, holds the tip of the saw in one hand and works the usual violin bow with the other. The vibrating steel blade emits soft, appealing notes the pitch of which is varied by changing the curvature of the blade. All sorts of queer effects can be obtained by the adept manipulation of the blade; in fact, the music derived by this means can hardly be described. If anything, it resembles the human voice; then again, it has the queer wail of the Hawaiian ukelelee. All in all, the effect is startling and pleasing.

Method of fiddling a saw to obtain pleasing music



Crushed German steel helmets make good road surfaces

Pavements of Crushed German Steel Helmets

ALL manner of odd uses have been found for German steel helmets. Flower pots, cuspidors, indirect lighting fixtures, wash basins—these and many other uses have served to make the German helmet a peacetime adjunct of some value.

Now comes the little town of Croydon, England, where much of the spoils of war have been placed, with the suggestion of using German steel helmets as road material. In fact, this township has gone to work and made some roads from German helmets with good results, according to reports. The helmets are arranged in the manner shown in our illustration, after which they are crushed up fine by a heavy road roller. Tens of thousands of these German helmets taken during the closing days of the war, serve to pave an appreciable amount of road surface. But after all, this is simply a "stunt" of questionable value.

Mortality Statistics of the United States

THE death rate of the United States for the year 1918 was 18 per 1,000 population, according to the bulletin on "Mortality Statistics" recently issued by the Bureau of the Census, Department of Commerce. This rate is based on statistics in the registration area of the United States, exclusive of Hawaii, which comprises 77.8 per cent of the total estimated population of the United States. The record of deaths in this area in 1918 totaled 1,471,367, including 26,209 soldiers, sailors, and marines.

The mortality rate for the registration area in 1917 was 14.2 per 1,000 population. The increase in 1918 is entirely attributable to the pandemic of influenza.

The greatest mortality occurred in children under five years of age, the total in this class amounting to 306,143. The second greatest mortality by age periods was among those from 25 to 29 years of age, and the third greatest mortality occurred among those between the ages of 30 and 34 years, inclusive. There were 733 deaths at the age of 100 years or over. Approximately 5.7 per cent of deaths occurred at the age of 75 or over. The average age at mortality was between 34 and 35 years.

The total number of deaths from influenza in the registration area (exclusive of Hawaii) was 234,290; from pneumonia in all its forms, 222,400; organic diseases of the heart, 124,514; tuberculosis, 107,602; acute nephritis and Bright's disease, 79,192; cancer, 65,282.

The report is known as Bulletin 141, Mortality Statistics, and can be obtained from the Bureau of the Census, Department of Commerce, Washington, D. C.

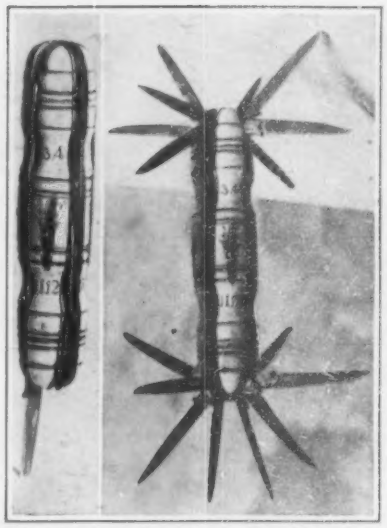
What a Falling Steel Girder Can Do

PEDESTRIANS of Regent Street, London, recently witnessed an accident that will long be remembered, when a girder weighing six and a half tons fell fifty feet to the sidewalk. The girder was being hoisted by a crane. Defective construction caused part of the crane to collapse, with the consequent drop of the beam. Curiously enough, the beam fell end on and pierced the pavement for some distance, as shown in our illustration. Fortunately, no one was hurt.

This girder, weighing 6½ tons, fell 50 feet and pierced the sidewalk

Standard Blood-Pressure Gages

THE U. S. Bureau of Standards has recently undertaken an investigation of the various types of blood-pressure gages in use throughout the country. The Bureau has constructed what is believed to be the first fundamental mercurial standard for testing sphygmomanometers.



Sixteen-bladed pocket knife which was used by Washington

Washington's Sixteen-Bladed Pocket Knife

QUITE aside from the fact that it was George Washington's pocket knife, the piece of cutlery shown in the accompanying illustration is interesting because of its sixteen blades. The many blades, it will be noted, are arranged to fold into four slots placed at right angles to each other in the handle. The knife was presented to our first President in 1784 by Captain Samuel De Wees, and is now the property of George De Wees of Chicago, Ill., a descendent of said Captain De Wees.

Our Leather Gloves in the Making

THE making of gloves has been placed on a quantity production basis, just as have most of our other everyday industries.

The first step in glove making is the selection of the leather skins which, after being passed on, are roughly marked off for the number of gloves to be made from them. The skins are then passed to the stamping machine, which, provided with the proper sized and shaped dies, cuts the material for each glove. It will be noted from the first of the accompanying illustrations that in this stamping operation all but the thumb is accounted for. The glove is made in one piece for the four fingers, the thumb being a separate operation. Following this operation the material is folded over and sewed into a glove.

The nearly finished glove is then steam treated, to give it the proper shape. A hollow metal form over which the dampened gloves are stretched, presses the gloves by steam heat after a few minutes' treatment. The gloves are then ready to be finished, including the attaching of suitable metal clasps.

Stamping and pressing operations in the manufacture of leather gloves

The Motor-Driven Commercial Vehicle

Conducted by MAJOR VICTOR W. PAGÉ, M. S. A. E.

This department is devoted to the interests of present and prospective owners of motor trucks and delivery wagons. The editor will endeavor to answer any question relating to mechanical features, operation and management of commercial motor vehicles

Truck and trailer outfit used in snow removal

Snow Removal by Machinery

THE big snow storm in the Eastern States recently brought out some strange snow-removing devices, and the inhabitants of the various cities, as they plodded through the trolleyless streets, found entertainment in watching the operations of the new appliances. One piece of snow-removing machinery which came in for much attention in New York was a 20-ton motor truck equipped with mechanism which enabled it to eat its way into a snow drift, the snow being carried up into the body and then ejected down a chute to the gutter or to a smaller motor truck running alongside. The owners of this machine stated that the tests showed it capable of removing 9 cubic yards of snow a minute, and able in a single day to do the work of 1,000 men. It will travel, say the owners, 5 miles an hour in from 3 to 4 feet of snow and will make a clearance 11 feet wide, throwing the snow 20 feet clear.

The severe weather obtained in all sections of the country throughout the winter as far south as Texas, as far west as the Pacific coast and throughout New England and resulted in choking many miles of highways with snow. To put these arteries of communication in condition for the traffic so essental to business of this country, it was necessary to call upon motor trucks because speed was essential. The increasing use of the truck for this purpose has come about through the pressing need for clear thoroughfares.

The accompanying illustration shows a typical outfit used in Salt Lake City this winter. Trucks and trailers were used to keep the roads clear of snow, while in almost every large city of the country similar fleets were in use throughout the winter. Even intercity transportation has assumed such importance that many of these companies ran their own plows to keep the roads used between cities opened. The importance of this rapidly developing new line of work for the motor truck may be gleaned from the fact that a recent snow storm in New York City required the services of 14,000 men working for a week to load trucks employed in clearing the snow away.

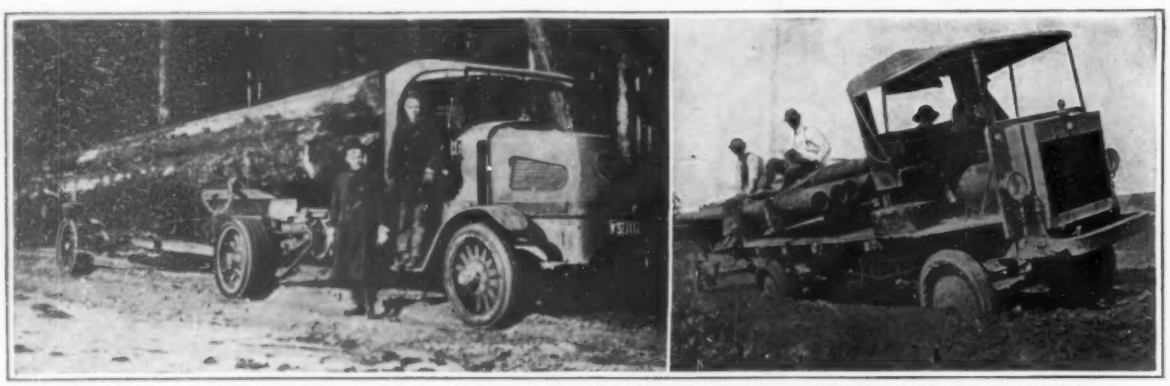
The gasoline mule in the shop

Trailers in Texas Oil Fields and Washington Forests

WE have previously mentioned the advantages of the trailer in many industrial uses for reducing hauling costs and new applications are constantly being made as the reduction possible in hauling expense becomes more evident to big business. Reports from Texas indicate that oil producers are realizing that trailers can be used effectively in their work. The great oil companies in the producing fields of Texas are using large numbers of two-wheeled pole trailers for hauling casing to their wells. The accompanying illustration shows a four-wheel-drive truck of standard make hauling a load of casings through a road of very poor surface.

Large distributing businesses such as

(Continued on page 444)

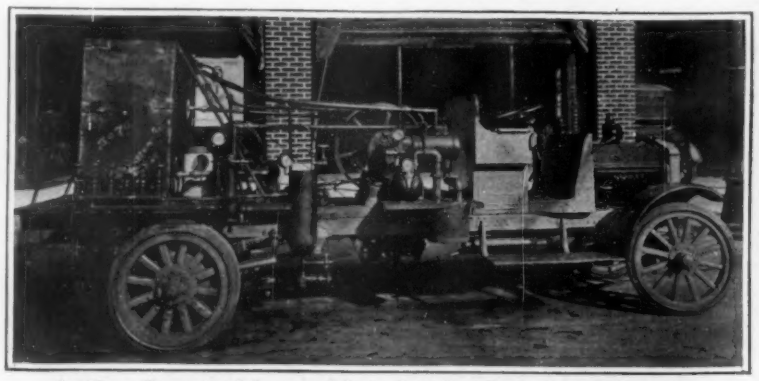


Truck and trailer in logging work in Washington, and truck and tractor hauling well casing in the Texas oil fields

The accompanying illustration shows a typical outfit used in Salt Lake City this winter. Trucks and trailers were used to keep the roads clear of snow, while in almost every large city of the country similar fleets were in use throughout the winter. Even intercity transportation has assumed such importance that many of these companies ran their own plows to keep the roads used between cities opened. The importance of this rapidly developing new line of work for the motor truck may be gleaned from the fact that a recent snow storm in New York City required the services of 14,000 men working for a week to load trucks employed in clearing the snow away.

A Gasoline Industrial Tractor

THE view shows an industrial tractor, driven by a gasoline engine, instead of the usual electric motor and storage batteries. It is designed to tow or push standard trucks or load-carrying vehicles or skids about plants for 24 hours per day. Gasoline is used as the motive power. The tractor is a rugged, all steel machine, built of the highest grade standard units, and able to withstand much hard use and abuse. It is not a remodeled automobile, but has been designed and built to fulfill the special requirements of industrial haulage. The machine has sufficient capacity to move freight cars and still operate economically on light loads. This apparatus is faster, more powerful and requires much less attention than electric propelled trucks of the same nature. The motor torque and drive ratios furnish a draw-bar ability approximately three times the tractive ability of the tires over average surfaces. Under average conditions this represents a trailing load of 10 to 15 tons. By special hook-up and traction arrangements a considerably larger per cent of the reserve torque of the motor can be utilized in such exceptional cases as spotting loaded freight cars.



Another oil-country job—a mobile testing plant for casing-head gasoline

The bill-board truck that carries its appeal throughout the country

Novel Advertising Truck

THE possibilities of the motor truck as an advertising medium have been realized to the full by a company producing a soft drink and located in St. Louis, who fitted up such a truck and sent it on a tour of the country early in January. Though trucks have been used for such purposes before, it is doubtful if so many features were ever embodied in an advertising truck. The company fitted up a two-ton chassis with a completely enclosed box body projecting over the driver's seat and carrying on four sides views of plants of the company. The "admobile" is actually a moving billboard, showing large billboard recessed in the sides of the car and flooded with light at night. On the top, across the front is an iron frame supporting a transparent screen, 6 x 8 feet. The projector for moving pictures is on the rear, thus giving a two-way view of the pictures.

Mobile Testing Plant for Casing-Head Gas

THE making of physical tests of casing head gas for determining the amount of gasoline contained in the gas is quite a job. A Tulsa, Okla., concern solved this problem in an unique way. They have mounted a special machine made by themselves at a cost of approximately $3,500 upon a two-ton truck chassis. It would take quite a lengthy article to describe fully the adverse conditions which have been imposed upon this truck in the matter of getting over bad country, as it is necessary for it to be taken to within 15 to 30 feet of each well, which in some cases seems to be a matter almost impossible, but it has never yet failed.

In making these tests the truck is backed up to the well where the testing plant can be attached in an instant. It requires from 6 to 12 minutes to complete a test on a well. The machinery weighs about 4,000 pounds, and is one of the most efficient gas testing machines that has ever been manufactured.

Why Is Gasoline High?

(*Continued from page 415*)

trust are producing, under keen nursing, from half a barrel of petroleum per day upward to six barrels.

When we talk of expanding the petroleum production, then, we speak without the book. We cannot count much on finding new fields, and we cannot count at all on making old fields yield more. So we must turn in the third direction, and try whether we cannot make the same amount of petroleum give us more gasoline. But here we encounter the economic obstacle. Right now we are using all the petroleum—we are wasting no fraction. If we make more gasoline, we must necessarily make less of some other fraction. What shall this sacrificed product be?

In practice it must be the kerosene or the fuel oil. And in practice we find it inexpedient to sacrifice either of these products. There is a large and peremptory demand for both of them; we will not make gasoline any cheaper by forcing its users to compete with this demand, even though we made gasoline a bit more plentiful in this way. And we certainly will not make gasoline any better by selling more and more of the less volatile fractions under the name gasoline—that is really what is the matter with the gasoline of today. A lot of material that formerly would have gone into the kerosene and fuel-oil fractions today has perforce to swell the gasoline total. The process has gone as far as it safely can—it is a process that will in any event seek its own economic level. Kerosene and fuel oil will be sacrificed for gasoline just as long as there is profit in so doing. This means, of course, as long as the prices of kerosene and fuel oil remain so low that the return from expensively-manufactured gasoline is greater than that from cheaply-made oils of lower volatility.

The producers of gasoline have naturally, within the commercial limits of their problem, been trying to meet that problem. The result of their efforts has not been zero. As our diagrams show, in a period when the ratio between automobiles and petroleum supply was multiplied by nine, the ratio between automobiles and gasoline supply only tripled—because we succeeded in getting three times as much gasoline out of a given amount of petroleum. But we are at the limit now—and the best we have been able to do has not been good enough to prevent automobiles from increasing three times as fast as gasoline production. Shortage? Of course there is a shortage. High prices? Poor quality? Of course—why not? How could it be helped?

All this means that for the present there is no prospect of improvement. For the future there are two possibilities. One is the real expansion of the petroleum supply through the Rocky Mountain shales. The present generation will be able to make nothing out of these deposits, as we have tried to explain in earlier issues. But the shales consitute a reserve of petroleum far greater than that of the oil wells, and some day we shall know how to get at it.

Another hope is in the Diesel engine. This is an internal combustion outfit that uses the heavy fuel oils. When we try to convert heavy oils into gasoline for the use of the present automotive engine, we must fail commercially; the result is gasoline of such poor quality and such high price that its use in motors is highly inefficient. The fuel oil which it represents can be used more efficiently in the ordinary ways, and hence the ordinary users can control the situation and the potential users of the gasoline cannot compete with them for the raw material. But with a Diesel engine in his car the autoist would speedily place the shoe upon the other foot. He would then be employing the most efficient machine for the utilization of that portion of the petroleum represented by the fuel oil; and the less efficient user of the fuel oil would then in his turn have to get off the track. When the Diesel engine is fitted into the automobile, if it ever is, the total supply of motor fuel will be limited only by the total supply of petroleum, and not by the percentage of that total supply which the automotive industry is able to capture.

Then there are always coal tar and alcohol as possible motor fuels. Here again the problem is distinctively up to the automotive engineer. And here again there is cold comfort for the immediate future. If a way were found tomorrow to burn crude oil or tar or alcohol or crop roughage or garbage in the automobile engine Mr. Average Car Owner would get no immediate benefit—for his car is designed to burn gasoline. He would have to wait for his benefit until somebody donated the price of a new car, or until enough of the new cars burning the new fuel had replaced the old cars burning the old fuel to put a crimp in the price of the old fuel.

House Surgery in the Building Crisis

(*Continued from page 418*)

and appealing color arrangement for the various rooms.

It will be seen, therefore, that this is not a job to be turned over to ordinary carpenters or contractors. It is a specialized job for a first class architect, and not every architect has the gift of working over old material. It is much easier to design a new home from the beginning than to accept the limitations of a structure already on the site, and to make the required change with economy and good taste.

The expert whose work is shown here has a gift for this kind of reclamation, because he abhors waste and would rather see an old house renovated than torn down. Together with the rest of the world, he has become sick of destruction, and his method of avoiding destruction, or waste, is to make something fit to live in and good to look at, out of an old building that most people would condemn.

Some of his jobs are little engineering feats. In one instance an owner wanted to keep a small house for sentimental reasons only. It was too light in construction to build upon, yet much additional living space was desired. The problem was solved by raising the old frame house and building under it, making the original structure part of the second story of a large and beautiful home.

In another difficult case, a city house only seventeen feet wide, was redesigned to make a charming little home, instead of a square and ugly pile of bricks and mortar, as originally built.

In every case the cost is less than building new, and in considering costs, one should remember the superior workmanship, lumber and material that so frequently went into the old houses.

With the shortage of houses we should make every building serve its purpose, and if house surgery develops as a check to our American habit of waste, it will no longer be a common sight to see a perfectly good house torn down because it is old or inconvenient or ugly.

Is the Dam Safe?

(*Continued from page 419*)

The air is permitted to flow quite gradually through the airpipe into the cell. Should the air pressure within the cell overbalance the soil pressure acting against the outside of the cell, electric contact is broken within the cell through the movement of the diaphragm due to the air pressure. This movement in all cases is less than one-ten-thousandth of an inch, and many examples evidence only one one-hundred-thousandth of an inch. When the electric contact is broken the air pressure in the pipe is instantly observed, the results being equal to the soil pressure.

(*Continued on page 434*)

Is the Dam Safe?

(*Continued from page 432*)

The instrument is being applied in practical tests for obtaining the pressure back of two high retaining walls, pressure under concrete roads, and in periodically denoting the effects of pressure on five enormous hydraulic-filled earth dams, in the process of construction to forestall floods similar to the one which visited Dayton, Ohio, in 1913.

California's Power Famine

(*Continued from page 419*)

manufacturing concerns and large users of power in the city are transferring their operations to night schedules, and all electric display advertising in the city is said to have been placed upon a war basis. Lights in store windows also have been discontinued and every effort made to see that the electric energy is conserved. The city is to cut down the electrolier system to half the present number of lights used, and Bakersfield has entered into a similar arrangement.

Every large user of water in California must coöperate to conserve the scant water supply now stored in the form of snow in the watersheds of the state. Never before in the history of this state has such an extreme condition of drought existed, nor have conditions of irrigation and power been so critical as at present. Between 100,000 and 300,000 cattle will have to be taken from California ranges to New Mexico, Arizona and Texas within the next thirty days unless rain relieves the grazing situation in the state.

There are eighty-four electric utilities in the state of California, operating seventy-five hydroelectric plants, with an installed capacity of 465,000 kilowatts, and fifty steam plants with an installed capacity of 305,000 kilowatts, making a total of 125 plants aggregating 770,000 kilowatts. During the year 1918 these plants generated a total of 2,892,000,000 kilowatt-hours. This power is transmitted through 7,300 miles of high tension transmission lines to points of distribution from which 84,000 miles of secondary distribution lines extend. Electric service is supplied to 545,000 consumers. The installed capacity of consumers' lights, motors and other power consuming devices exceeds 1,800,000 horse-power. Nearly 900,000 kilowatts of distribution transformers are installed on these systems.

The Romance of Invention—XI

(*Continued from page 420*)

off and breaking, he turns the support in minute ball bearings as fast as the compass turns. The whole mechanism, weighing many pounds, is revolved by an "azimuth motor" which operates electrically in response to the least touch of an electrical contact controlled by the gyroscope. The result is an instrument which is so sensitive that there is no destroyer which can turn in a circle faster than the gyroscope compass can keep up with it.

There is a factory in Brooklyn where some twelve hundred employees make gyroscope compasses and other things, and here the curious who has Mr. Sperry's permission may see some fifteen of these instruments completed every month, and, after most interesting and dainty tests, in which they are rolled and pitched and tossed and moved and jarred and generally subjected to more and worse motions than they could ever experience on shipboard, turned over to Uncle Sam for installation on the many boats of his official fleet. So vitally important has the gyroscopic compass become that, during the draft, it was ordered from Washington that Sperry employees must be exempted from service.

The gyroscopic compass is not only now the direction finder for ships, but is an integral part of the most important thing the fighting ship has to do. It is indispensable in gunfire control, and upon the accuracy of its functioning depends the accuracy of the guns which sunk the submarines. Every shot which the British fleet fired at Jutland was directed by a Sperry gyroscopic compass.

One goes to see Mr. Sperry, quite aware that all this is so, and yet not half believing it. But if you find him not too busy—which is difficult—he will bring forth a little hand gyroscope and demonstrate it to you and then take you through the factory where these little marvels of accuracy and harnessers of Mother Earth are put together.

"But I have heard of gyroscopes for something else than compasses. Don't they do something to make ships steady?"

They do. On seventeen ships they have proved what a scoffing world declared to be an impossibility—they take the roll out of the ocean. The same principle which makes the gyroscopic compass operate makes the gyroscopic ship-stabilizer operate—that is, the fact that gyroscopes resist the application of force to throw their axles out of parallel, with an equal force, exerted at right angles.

Suppose a ship had a mast a mile high. Suppose from that mast were suspended a heavy weight on a pendulum, and that some giant stood beside the ship and dragged the pendulum to the east when a big wave tried to roll the ship to the west. If the giant were skillful, the ship would not roll, because the pull of the pendulum, eastward, would be equal to the power of the wave, rolling the vessel westward.

Something like that is the action of a gyroscopic stabilizer, only instead of a pendulum a mile long, we have one or more gyroscopes, their combined weight equal to half of one per cent of the vessel's displacement, turning at speed. Along comes a wave and rocks the ship. At the first faint movement, a "control gyroscope" moves itself; because a gyroscope *will* move, and move quickly, in the effort to resist throwing its axis out of position. The control gyroscope makes an electric contact. The electric contact operates a motor. The motor moves the big or stabilizing gyroscopes so that the force they exert, in resisting that change of position (remember it is at right angles with the disturbing force) is exerted against the ship in the opposite direction to that of the rocking-the-boat wave.

The result is that the ship rests steady in the water.

Not an experiment—a proved fact. Seventeen ships, big and little, have tried it—now comes a great passenger liner to have the controlling gyroscopes installed, and Mr. Sperry is confident that before very long the only rolling ships will be the old ships, the ships too small to make it worth while to install stabilizers, and the sailing ships.

These are two fairly large and impressive accomplishments for an inventor to have to his credit—and either is big enough for a pretty big manufacturing business. But if you see all the Sperry plant you are bound to see search-lights—regular he-man search-lights, and you don't doubt it at all when your guide tells you that one of them develops 1,600,000,000 candle power, or that it is as bright as the sun. If the visitor is familiar with army and navy material he will soon recognize these giant search-lights as the army and navy brand, and learn without much astonishment that the Sperry plant turns out dozens of them for the navy and army; because Mr. Sperry made possible the vastly greater candle-power of the Sperry light.

In its simplest form, a search-light is an arc with a reflector behind it; but these are not simple. In the first place the arc is a special kind of arc, an arc made with special carbons in which the one which burns to a crater has a softer core than shell. The result is the crater is deep, and the little bubble of incandescent carbon gas, which gives off the

(*Continued on page 436*)

For great valves or window screens; for mine pumps or automobile fittings; for turbines or spark plug electrodes—everywhere a metal in giant casting or tiny wire must resist rust, acids, alkalies or chemically tainted waters; retain strength under high heat, or resist the destructive wearing action of hot gases or superheated steam.

MONEL, because of its unique characteristics, is the most perfectly balanced of all metals. Strong as steel but without its limitations, non-corrodible as copper, yet harder, more durable and acid resisting than bronze—MONEL possesses a wider range of usefulness than is possible with any other available metal or alloy.

And for these reasons MONEL is now extensively employed in industries where the mechanical and chemical requirements are unusually exacting, as well as for a variety of common domestic uses.

Among the many purposes for which MONEL renders a service that effects great economy over the material previously used are power plant apparatus, chemical equipment, marine fittings, special parts of machinery, chain, nails, screws, surgical instruments table cutlery, and golf club heads.

MONEL Metal is a natural alloy composed of 67% nickel, 28% copper, and 5% other metals. It can be machined, cast, forged, rolled, drawn, brazed, soldered, and welded by electric or oxy-acetylene method. It takes and retains a perfect nickel finish.

An increasing number of manufacturers regard MONEL as indispensable for hundreds of purposes where a combination of great strength, non-corrodibility, and durability is required.

Our experience as sole producers of MONEL Metal since its discovery in 1905, is at your disposal through our Sales or Technical Departments.

The International Nickel Company has served industry for more than half a century through the production of a wider variety and increasing number of better Nickel products. In purchasing INCO Monel Metal, INCO Nickel, and other INCO Products, you are assured of the highest and most uniform grades that the world produces.

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The Romance of Invention—XI

(*Continued from page 434*)

light, is larger and hotter and so brighter than the corresponding bubble in an ordinary search-light, which has no deep crater to hold it in. The Sperry search-light is automatic and adjusts itself so that this little bright bubble is always exactly in focus and stays in the same position with reference to the center of the parabolic mirror—all of which takes electrical and mechanical apparatus which must be two opposite things at the same time: dainty and responsive while rugged and strong.

One by no means gets to the end of his acivities with telling what Mr. Sperry is doing now. No account, no matter how skeletonized, of the life of an inventor who makes inventions as other people write letters—as fast as the need comes—would be complete which did not at least mention the mining machinery he invented, which revolutionized mining methods, and the manufacture of which is today a great business. That story has been told before, but one little incident in it will bear retelling here. Up to the time Sperry mining machinery was introduced, what power tools *were* used were run by compressed air. Sperry's machinery was to be run electrically. Mining engineers laughed at him, because of the known fact that the sulfur and sulfur water of mines eats up copper wires. But Sperry persisted and put down his copper in the mines. It is in use today. It didn't corrode—because as Mr. Sperry knew, no conductor *carries electricity without having its temperature raised*. And if the wires were warmer, no matter how little warmer, than the surrounding air in the mine, they would not condense moisture, would remain dry, and hence would not be subjected to the action of the suspended sulfur.

The impatient reader may begin to think it about time to say something about Sperry the man. And indeed, Sperry the man does not shrink in proportion as one views the magnitude of his work. But Sperry's work and Sperry are so much one with each other, and Sperry the man is so much more interested in the work than in himself, that it is only natural to speak first of his achievements and then of the achiever.

He is quick, alert, vivid, vigorous in speech and action. He thinks fast, very fast. His speech is snappy, like his eyes. It is also picturesque. "Only the impossible is worth doing" is one of his phrases. "There is always a way through; every blind alley has an end if you hunt it long enough" is another. And a third, perhaps not formulated in words, is to the effect that anything worth while at all is worth doing, but that only something very *much* worth while is worth doing for any length of time, regardless of how much financial reward might come out of the lesser thing if pursued.

Mr. Sperry is catholic in his inventions—mining machinery, storage batteries, electric lights, gyroscopic compasses, the stabilizer, engines, rotary and chain coal cutting equipment, electric automobiles (he drove the first American-built car in the streets of Paris in 1896), and a hundred others. Many of them have resulted in large businesses, such as his own, and the Chicago company which produces his mining machinery.

As an electro-chemist Mr. Sperry has had a distinguished career. A founder of the American Electro-Chemical Society and originator of standard electro-chemical and battery equipment, he is also the inventor of a detinning process used in a great commercial concern as well as patentee of machinery on which a prominent maker of fuse wire does business.

Mr. Sperry, something short of sixty years young, has carried around a weight of distinctions and memberships for a number of years. A partial list includes: The first prize of $10,000 from France in the International Aerial Security Contest for the airplane stabilizer. The Franklin Institute medal of Philadelphia for the gyro compass, the SCIENTIFIC AMERICAN medal for the compass and the stabilizer, the grand prize of the Panama Pacific Expositon for the gyro compass, the Collier Aeronautical Trophies for the years 1915 and 1916.

For any man to have produced a single great invention is a large achievement. When one man produces not one but dozens, and not one but dozens of great businesses are conducted on his ideas and based upon his patents, we naturally conclude that here is an original genius which the world could ill spare. Mr. Sperry's work must always stand as an inspiration to inventors in general, but more especially to those who delve in the as yet uncharted depths of science. That a man can harness the motion of the earth and make it work, that he can dig out of the abstruse deeps of the mathematics of the gyroscope a means for steadying ships and making a steady platform for battleship gunfire in a high sea, is but another way of saying that there is plenty new under the sun awaiting discovery and that fame and fortune wait now, as they have always waited, on the man of original thought, of constructive, synthetic ideas—on the true spirit of invention.

Uncle Sam—Motion Picture Producer

(*Continued from page 422*)

mission fee will be charged. Naturally the Government motion picture laboratory is designed primarily for the production of negative and hence its resources do not permit of supplying large numbers of prints. For the most part the various state agricultural colleges supervise the distribution of the pictures throughout their sections and all educational agencies may secure the films from these sources. This arrangement permits of intensive distribution and simplifies transportation problems.

Recently one of the most valuable motion pictures, "Dust Explosions in Mills and Elevators," has traveled 15,000 miles during a period of three months and been exhibited at 40 meetings in 25 states, to more than 7,000 experts actively engaged in the grain milling and elevator business. By special request of the Canadian government it was shown at Fort William, Ontario, to 500 grain dealers and mill operators. This picture illustrates how a strictly educational film may also carry plenty of thrills, as destructive explosions due to the ignition of suspended grain dust by a spark are graphically portrayed. In making these pictures, a steel chamber in one of the large Pittsburgh plants was used. In one instance the rate and violence of the explosion exceded the anticipations of the engineers and camera man, with almost fatal results to these participants. The picture also shows efficient means of preventing explosions — dampers, automatic relief valves, suction sweeps, dust collectors and other fire fighting apparatus.

The series utilization of motion pictures to depict agricultural activities is well demonstrated in an aggregation of 11 reels which deal with the production, transportation, grading and marketing of wheat. This series of pictures shows the practical application of important discoveries of the Department of Agriculture. It influences the production of more and better wheat; it presents methods of minimizing losses and it pictures superior handling systems, all of which are directly or indirectly the fruit of Uncle Sam's efforts.

Actual farmers may lack in histrionic ability, but usually they are extremely expert in the routine work which they

(*Continued on page 438*)

"They always come back to Your Oil"

How Manufacturers of Automobiles, Tractors and Trucks Seek to Protect their Engines

A manufacturer writes to us:

"We have always carried on a considerable amount of experimental work in connection with lubrication and have held our specification regarding oil very closely to Gargoyle Mobiloils.

"As we are commencing shipments into England, and also France, we are very anxious to get our customers in these countries started on your oils . . .

"We have found that a sample can of Gargoyle Mobiloils going with the machine is important, inasmuch as our customers get excellent service as long as they use the oil supplied *and are very prompt to return to your oil* as soon as they have tried something else, as they usually do, and find that they do not get the results."

Engine results depend upon scientific lubrication.

Engine results account for the fact that you seldom find a motorist who "used to use Gargoyle Mobiloils."

Gargoyle Mobiloils are refined from crude oils specially chosen for lubricating qualities—for *engine results.*

Get engine results. The present cost of automobiles, spare parts and repair service warrants the use of scientific lubrication as never before.

For engine results—consult the Chart at the right.

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Mobiloils

A grade for each type of motor

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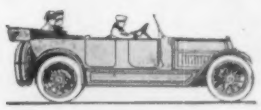
Boston	Chicago	Detroit	Minneapolis	Kansas City



Correct
AUTOMOBILE LUBRICATION

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Mobiloils

A grade for each type of motor

Gargoyle Mobiloils for engine lubrication are:

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Gargoyle Mobiloil "B"
Gargoyle Mobiloil "E"
Gargoyle Mobiloil Arctic

The Chart below indicates the grade recommended by the Vacuum Oil Company's Board of Engineers. The recommendations cover all models of both passenger and commercial vehicles unless otherwise noted. If your car is not listed in this partial Chart, send for booklet, "Correct Lubrication" which lists the correct grades for *all* cars.

AUTOMOBILES	1920 Models		1919 Models		1917 Models		1916 Models		1915 Models	
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter*	Summer	Winter
Allen	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Auburn (4 cyl.)							A	Arc	A	Arc
Auburn (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Auburn (6–39)					A	Arc	A	Arc		
" (6–50) & Tractor-H			A	Arc						
Autocar (2 cyl.)	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Briscoe	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (8 cyl.)							A	A		
Buick	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Cadillac (8 cyl.)	A	A	A	A	A	A	A	Arc	Arc	Arc
Case	Arc	Arc	Arc	Arc	A	Arc	A	Arc	A	Arc
Chalmers			A	A			A	Arc	Arc	Arc
" (6–40)							A	Arc		
" (6–50)	A	A			A	A	A	A		
Chandler Six	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Chevrolet	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A				
" (F.A.)	A	Arc	A	Arc						
Cole							Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A	A	A
Cunningham									Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A		
Dart	Arc	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
" (Model C)							A	Arc	A	Arc
" (2 and 3½ ton)	A	A	A	A						
Dodge Brothers	A	Arc	A	Arc	A	Arc	A	Arc	E	E
Dort	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Federal	Arc	Arc	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" (Mod. S-X)			A	A	A	A				
Federal (special)			Arc	Arc						
Fiat			B	A	B	A	B	A	B	A
Ford	E	E	E	A	E	A	E	A	E	A
Franklin	A	A	A	Arc	A	Arc	A	Arc	A	Arc
Grant	A	Arc								
" Con't	Arc	Arc								
" (Model 12)	A	Arc								
Haynes	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A		
Hudson							Arc	Arc	Arc	Arc
" & Super Six	A	Arc	A	Arc	A	Arc	A	A		
Hupmobile	A	Arc	A	Arc	A	Arc	A	A	A	Arc
Kelly Springfield	A	A	A	A			A	A	A	A
King									A	Arc
" (8 cyl.)	A	A	A	A	A	A	A	Arc	Arc	Arc
" Commercial			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Kissel Kar	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" " (Model 48)	"	"					A	A	A	A
" " (12 cyl.)	"	"	A	A	A					
Lexington	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Leppard Stewart			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" " (Mod. M					A	Arc	A	Arc		
" " (Mod. MW					A	Arc				
Locomobile	A	E	A	E	A	E	E	E	E	E
McFarlan			A	Arc	A	Arc	A	A	A	Arc
McLaughlin	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
McLaughlin (Mod. E6)	A	A	A	A						
Madison			A	Arc	A	Arc	A	Arc	A	Arc
" (8 cyl.)					A	A	A	A		
Marmon	A	A	A	A	A	A	A	A	A	Arc
Maxwell	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Mercer	A	A	A	A	A	A	A	A	Arc	Arc
" (12-70)									A	Arc
Mitchell	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
" (8 cyl.)							A	A		
Moline-Knight	B	A	B	A	A	A	E	E	A	A
Monroe			A	Arc	A	Arc	E	E	A	Arc
" (Mod. M4)			A	A	A	A				
" " (Mod. S)	A	A								
Moon			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Nash	A	Arc	A	Arc						
" (Mod. 671)			A	A						
" (Quad)	A	A	A	A						
National	Arc	Arc	Arc	Arc	Arc	Arc	A	Arc	A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A		
Nelson	A	A	A	A	A	A	A	A		
Oakland	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)							Arc	Arc		
Oldsmobile (4 cyl.)	A	Arc								
" (6 cyl.)	A	A	A	A	Arc	Arc	Arc	Arc	Arc	Arc
" " (8 cyl.)	A	A	A	A	A	A	A	A		
Overland	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Packard									A	Arc
" (12 cyl.)	A	A	A	A	A	A	A	A		
" Commercial	A	A	A	A	A	A	A	A	A	A
Paige (4 cyl.)									A	Arc
" (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (6–36)							A	Arc		
" (6–38–39)					A	Arc				
" (6–46)									A	Arc
Paige (Con't)	A	Arc	A	Arc						
Paterson	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Peerless			Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (8 cyl.)	A	A	A	A	A	A	A	A		
Pierce Arrow	A	A	A	A	A	A	A	A	A	Arc
" Con't	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
Premier	A	A	A	A	A	A	A	Arc	A	Arc
Regal	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
(6 cyl.)							A	Arc	A	Arc
Renault (French)							A	Arc	A	Arc
Reo	A	Arc	A	Arc	A	Arc	A	Arc	A	Arc
Riker	A	E	A	E	E	E				
Saxon	E	E	E	E	E	E	E	E	E	E
Selden	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (3½ ton)							A	Arc		
Simplex Crane			A	A	A	A	A	Arc	Arc	Arc
Stearns-Knight	B	A	B	A	A	A	B	A	B	A
Studebaker	A	Arc	A	Arc	A	Arc	A	Arc	Arc	Arc
Stutz	A	A	A	A	A	A	A	A	A	A
Velie (4 cyl.)									A	Arc
" (6 cyl.)	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
" (1½ & 2½ ton)	Arc	Arc	Arc	Arc						
" (3½ ton)	A	Arc	A	Arc						
Westcott	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc
White	Arc	Arc	Arc	Arc	A	Arc	A	Arc	Arc	Arc
" (Sixteen Valve)	A	A	A	A	A	A				
White (1 ton)	A	A	Arc	Arc						
Willys-Knight	B	A	B	A	A	A	B	A	B	A
Willys Six	Arc	Arc	Arc	Arc	Arc	Arc				
Winton	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc	Arc

Uncle Sam—Motion Picture Producer

(Continued from page 436)

perform. That is why their operations are fertile material for the movie man. "Apples and the County Agent" is a three-reel production which concerns the efforts of the agricultural extension service to convert John Hanson, a real Maryland farmer, from an unsuccessful grower of farm produce into a successful producer of high grade apples. The remarkable success of this film has been largely due to the fact that the cast were real farmers, who were photographed performing agricultural tasks to which they were accustomed.

Uncle Sam does not have to rent or build locations as he has the entire country over which to stage his pictures. The national forest reserves furnish ideal settings for many of the instructive films relating to forest conservation, forest fire control, forest ranger activities and like enterprises connected with preservation of woodland resources and the domestic lumbering operations. Through the co-operation of the motion picture industry a forest fire prevention campaign was staged during a period of three months throughout California which was instrumental in saving from destruction thousands of trees in the private and public forests.

The latest pictures completed cover such subjects as safeguarding the citrus fruits, poultry pests and their control, the last days of the prairie dog, granite paving and curbing, the control of hog cholera, the Wichita National Forest and Game Preserve, the potato industry in America's Netherlands, To Feed a Hungry World, agricultural forest resources, the control of the pink boll-worm, the western cantaloupe industry, Why Eat Cottage Cheese? saving breeding cattle, the control of cattle parasites, the national forests as the nation's playground, logging timber for wooden ships and how they are constructed, meeting farm labor problems—and many more.

Many of the farming enterprises or particular scientific processes filmed by Uncle Sam cover various periods and cycles so that in many instances it takes twelve months or longer to obtain all the descriptive negative essential for one picture. The facilities provided by the 45 or more state agricultural colleges are available for the staging, while most of the private industrial, commercial and manufacturing concerns are ready and willing to give the government a helping hand in the preparation of its educational films. Under such circumstances of complete and extensive scientific and practical equipment it is not surprising that the Department of Agriculture is producing some of the most instructive and interesting pictures which have ever been exhibited.

Among the Mountains of Western Canada

(Continued from page 424)

is taken unaware. Warned by distant thunder we did not linger but reached the summit in about an hour and three quarters. Here we enjoyed a view of great extent, comprising a multitude of peaks from Hungabee and Deltaform near Lake Louise to Mt. Forbes in the north and Sir Donald in the Selkirks to the west. Near at hand was the white summit ridge of the President.

No matter how often one may visit Lake Louise, its beauty and charm are perpetually satisfying. The brilliant poppy covered slopes of orange, white and yellow are a most effective setting for the ever-changing greens and blues of the lake; while the avalanches and the alpine glow on Mt. Victoria linger long in memory. Within easy distance by trail is flower-strewn Paradise Valley filled with the music of waterfalls and surrounded by glacier-hung peaks of unusual grandeur.

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The most interesting approach to the valley is over the Saddle with its splendid outlook on Mt. Temple 11,626 feet. On the way one may climb Fairview which is only 9,000 feet in height, but its view of the snowfields and glaciers surrounding Lake Louise is exceptionally fine. On the right of the valley is the Mitre, 9,470 feet, a lively climb up cliffs of disintegrated rock requiring frequent testing of hand and foot holds. Now and then we had thrilling glimpses of the abyss into which we tumbled stones, the sound of whose fall never reached our ears. From the summit we viewed the wild grandeur of surrounding peaks and glaciers, and we watched the avalanches sliding off the nearby ridgepole of Mount Lefroy.

On the eastern side of Paradise Valley Pinnacle Peak rises 10,062 feet, with sheer precipices which were long unclimbed. As we went westward through the Selkirks, we found that the scenery of Rogers Pass and the Illecillewaet Glacier was hidden by the new tunnel; but the backward view of the vast pyramid of Sir Donald, with Uto and Eagle Peaks, mingling with the snowy cloud mountains of the sky, is never to be forgotten.

At Vancouver we worked our way along the tangled slopes of Capilano Canyon, following the remains of an old flume. Magnificent hemlocks border the gorge and the thick growth of large ferns is a constant delight. A logging railway is bringing absolute destructon to the region and desolation is spreading toward Grouse Mountain. Shingles and laths are more valued than scenery, but such devastation will sooner or later affect the water supply of the region. Stanley Park is altogether delightful in sunshine, rain, or moonlight. Giant cedars tower majestically above a tangled undergrowth festooned with moss. A thick carpet of exquisite ferns grows in utmost profusion, and scarlet lilies and delicate sprays of rose-red huckleberries enliven the verdure. Low arching maples form fairy grottoes with many a setting suggestive of the opera. There is a peculiar charm about the quiet city of Victoria with its flower-embowered bungalows and the varied evergreens of its ocean park. Across the straits of Juan de Fuca the Olympics linger rose and purple in the twilight like the mountains of Japan.

The Topical Lamp Post

(Continued from page 425)

much attention that promoters who noticed that the seals attracted sightseers, started a summer resort there. One of the most distinctive things about Seal Beach is a concrete street lamp post, with three seals at the top. These seals are standing upright, as real seals sometimes do, and on their heads is a frame which supports an octagon bulb shield of tinted glass. These posts are to be found on both sides of the long paved promenade which is a replica of the boardwalk at Atlantic City.

San Gabriel, where the historic old San Gabriel Mission is situated, has recently emphasized the historic value of the Mission by installing street lamp posts which carry out the Mission idea in architecture in an excellent manner. The post is a modest affair, with a crossarm supporting a bell-shaped globe at each end, carrying out the Mission scheme effectively.

Alhambra, a city not far from San Gabriel, adds to the historic value of the Mission, and symbolizes the King's Highway by installing all along the King's Highway through the city a lamp post with a Mission arch at the base, in which is stamped a Mission bell with a star and crescent below it. The base of this post accentuates the Spanish or Mission type of architecture with great faithfulness.

The Shriners of Los Angeles, carried the symbolic street lamp post idea one notch further when they erected Shrine Auditorium. All along the street in front of the Auditorium they erected steel posts

at the top of which the Shrine emblem was worked out in electric sign fashion, the entire face of it being dotted with small electric light bulbs which carefully trace out the Shriners' emblem in the darkness. This is one of the most distinctive of the symbolic lamp posts to be found in southern California, and its value from a publicity standpoint, like all the others, can scarcely be questioned.

Plant Growths That Shed Light

(*Continued from page 427*)

disappears. The mycelium of the hymenophore of this species is not luminous even when most active.

On the other hand, the sclerotia of *Gymnopus tuberosus* are said to be luminous; and the writer has observed that the mature hymenophore of *Panellus styticus* may be luminous when the young ones are not. *Xylaria Hypoxylon* is reported luminescent when growing naturally but not in pure cultures, which may possibly be due to the association of photogenic bacteria or other light-producing organisms.

The most notable of the luminescent fungi is probably *Monadelphus illudens*, or the "Jack-my-lantern"; a large, orange-colored, poisonous mushroom, which occurs through the eastern United States from mid-summer to late autumn in showy clusters about dying trunks and stumps of deciduous trees. The clusters are sometimes very dense and the individual caps over 6 inches across. One found by a farmer near Oxford, Ohio, measured 90 inches in circumference and 15 inches in height, and contained between 200 and 400 fruit-bodies.

A few years ago, late in August, I was fortunate enough to find several bushels of this fungus in a piece of woodland east of Bronx Park, most of which material was used in chemical analysis and experiments to determine the character and effect of the poison on frogs and turtles. It was found to paralyze the nerves controlling the action of the heart, and to cause nausea, vomiting, and diarrhoea.

Tiny Creatures That Make Bad Water

(*Continued from page 427*)

The aromatic odors of drinking water, together with the grassy or "hayey" odors are, in the main, caused by the growth of the algae, the worst of these being the characteristic "pig-pen" odor resulting from the abnormally large growth of certain of the filamentous species, and thought to be due to the high nitrogen content of the bodies of these forms.

Possibly the most objectionable of the water odors and tastes are those of the fishy variety, produced chiefly by the over-growth in numbers of the protozoa, or unicellular animals. These odors and tastes are the results either of the growth or of the disintegration of the tiny creatures.

With the growth of some of the noxious protozoan forms certain organic oils are liberated from the body which may impart to the water a flavor distinctly different from that due to the oils which may be disseminated from the body after the death and disintegration of the animal. Furthermore, odors and tastes sometimes differ in *quality*, as their intensity changes. Thus an odor or flavor which may be innocuous, or even pleasent in stronger amounts. In many instances but faintly detected, often becomes disagreeable or even nauseating when present in stronger amounts. In many instances these odors and tastes are characteristic of the organisms producing them, and the kind, or species, of the offending organism, can, therefore, sometimes be determined upon the criterion of odor or taste alone. The amount of what may be termed *protozoan oil* required to produce an appreciable odor in drinking water is, in some cases, extremely small. Thus the oil occasioned by *Synura* (Figs. 5 and 6) can be readily detected when diluted in water to the extent of one part in 25 million! That this oil is of remarkable intensity of odor will be appreciated when it is stated that oil of tansy, which is intensely penetrating, does not give off a sensible odor when diluted with more than one million times its volume of water. Oil of peppermint, however, can be recognized by its odor in a water dilution of one part in 50 million.

Preventives of the growth of the flavor-producing protozoa are much more to be desired than reagents which kill the organisms after they have put in their appearance. Killing the creatures does not at once remove the objectionable flavors which they impart to water; in many cases it may even intensify the evil by assisting in the liberation of a greater number of the oil globules, at one time, from the disintegrating dead bodies. Filtration by special means, and aeration of the contaminated water must then be resorted to. By checking the undue increase of these forms, either by natural or artificial means, odors both of growth and of disintegration are at once prevented, and the need of special filtration and aeration dispensed with.

The protozoa (Greek: *protos*, first; *zoon*, animal) are largely purely microscopic forms, though some of the larger species like *Dileptus gigas* (Fig. 13), and *Bursaria truncatella* (Fig. 11), and a few others are faintly visible to the unaided eye if a small quantity of water, containing large numbers of the creatures be held between the eye and the light. Some of the minuter forms, those classified among the *Mastigophora*, or Lash Bearers may even be as small as two micra in lngth, which is approximately one-fifth the size of the single *Uroglena* shown in comparison with a human hair in Fig. 1. An individual protozoan body consists of a single cell, provided (in the case of the free-living, nonparasitic forms) with various characteristic organs of locomotion, or food-getting. Those concerned in pollution of drinking water belong mainly to the order *Mastigophora*, or Lash Bearers, an order which includes a vast host of the minuter species of the protozoa. The *Sarcodina*, or Sarcode Bearers seem never to be present in troublesome numbers, nor do the *Suctoria*. The ciliates occur frequently in dense masses, more often in foul waters. and one species, at least is troublesome in drinking waters (*Bursaria truncatella*, Fig. 11), producing a fishy, or salt marsh odor and flavor.

Cryptomonas, in small numbers, gives to the water a faint violet-like fragrance, which, not at all unpleasant, and indeed often agreeable at first, rapidly becomes objectionable as the numbers of the organisms increase. Fig. 8 shows a common species, *Cryptomonas ovata*, common in pond or river waters. It possesses two broad lateral bands containng chlorophyll, or green coloring matter, and termed chromatophores. A pair of short flagella arise from the anterior end of the body. A very large number of these forms in reservoirs impart to the water a grayish green color, giving it an unsightly appearance. This species is one of the larger among the flagellates, often reaching a length of over 60 micra. Its normal size is 45 to 50 micra.

Another organism, producing a fragrance like that of violets, when present in the water in small numbers, is *Mallomonas*. As the numbers increase a very disagreeable fishy odor and flavor is imparted to the water, particularly when the dead bodies of the individuals are undergoing disintegration. A frequently encountered form (not yet given specific appellation) is shown in Fig. 10. In this form the chromatophores are yellowish, and narrower than in *Cryptomonas*. The body is elongate, and is enclosed in a thin, hyaline membrane, composed of imbricate, roughly hexagonal plates, each of which bears a long slender spine. The animal progresses rather slowly through

the water, drawn forwards by the lashing of the single flagellum, located at the anterior extremity of the body.

Among the most troublesome of the protozoan polluters of water must be included *Uroglena*. *Uroglena americana* (Fig. 2) is a colonial form, composed of a multitude of independent organisms all held together in a symmetrical mass by a globular or ovoidal body of gelatinous consistency, the matrix. The individual organisms are ranged about the outside of the mass with their anterior ends, which bear the flagella, projecting outward. Although thus held together, each individual is capable of living an independent existence, there being no physiological connection between the members of the colony. The whole colony is impelled through the water with a rolling motion, by the beating of the numerous flagella. Fig. 3 shows an individual *Uroglena*, such as may often be seen, separated from the colony. Apparently this organism as often leads an independent existence as a colonial one. When individuals are thus found solus, it can be seen that the body is capable of being altered in shape, apparently at will, and that all individuals are not the same size. The flagella are always two in number, of unequal length. The minute size of this species is indicated in Fig. 1, where a single individual and a human hair, both magnified to the same extent, are shown.

Synura is also a colonial form, resembling somewhat the preceding species in its communal organization. The colony (Fig. 5) is composed of from 35 to 55 individuals, held together, not by a gelatinous matrix, but by delicate, transparent, stalk-like processes arising from the posterior extremities of the animals. The whole colonial ball progresses through the water in an irregular path, rotating on its axis, first this way and that, due to the propulsion of the numerous flagella. The colonies are not always symetrically globular, and may also vary in the numbers of component individuals. Each member of the colony, or zoöid, is enclosed in a delicate membranous envelope, and bears two flagella of unequal length (Fig. 6). On each side of the body is located a broad, crescentric chromatophore, or yellowish brown hue. The normal length of the body is 30 micra. Solitary *Synurae* are often encountered, but apparently the colonial habit is much stronger in this species than in *Uroglena*. *Synura*, in large numbers, gives to the water an odor like that of fresh cucumbers; a distinctly bitter taste; and often a brownish, or muddy appearance.

Dinobryon, represented by *Dinobryon sertularia* (Fig. 9), is also a colonial species, different in structural organization from either *Synura* or *Uroglena*. Each member of the colony is encased in a tough, transparent, vase-like case, called a lorica, through the open distal end of which the long body flagella project. The length of each lorica is usually from 18 to 25 micra. The body of the animal does not fill the lorica, but is withdrawn for protection, well within it, being normally about 10 to 15 micra in length. While there is no organic connection between the bodies of the various members of the colony, yet the individuals seem never to be able to live long after having been torn apart. *Dinobryon* develops rapidly in ponds and reservoirs, where it imparts to the water a fishy, or sea-weedy odor and taste.

In *Peridinium* (Fig. 14), of which there are several species, the body is armored with a series of polygonally shaped plates, which are transparent and reveal the yellowish, brownish, or greenish color of the body within. Two flagella are present, arising from a furrow which encircles the body. The body is ovate in form, with a flattened ventral surface, and an arched, or domed, dorsal one. Waters containing large numbers of *Peridinium* are grayish and cloudy looking, give off a fishy odor and possess a taste sometimes like decay-

ing fish, or more often like stale clams.

Glenodinium is one of the smaller of the water polluters, being normally about 20 micra, or less, in diameter. The form is roughly globular, or slightly flattened, and the body is encircled by a deep, well-defined median furrow (Fig. 4). The body is enclosed in a delicate cuticle, which shows no markings nor plates and bears a single, long, vigorous flagellum arising from the furrow in the middle of the body. This species is one of the less noxious forms, and when present in large numbers gives to the water a rather weak fishy odor and flavor.

Euglena sanguinea (Fig. 7) develops but rarely in reservoirs, being usually confined to ponds and feeble streams. It gives to the water a pinkish or sometimes a deep red appearance, and when disintegrating, a strong fishy odor and taste.

Another form, *Euglena haematodes* (Fig. 15), is sometimes associated with *E. sanguinea*, which it nearly resembles. Walton states that during the months of July and August the former species causes certain pools in Ohio and other states to turn red, and the writer has observed the coloring of pond and ditch waters from the same cause in southern Connecticut. Like *E. sanguinea* large numbers of these individuals give the water a fishy character, particularly noticeable on a hot day. Both of these forms develop rapidly and are capable of filling a large pool in a few days' time.

Of the ciliate protozoa which contaminate drinking waters but one species as yet has reached any importance as a pest. This is a very large form, of which *Bursaria truncatella*, a common form (Fig. 11), ranges in size from 450 to over 700 micra in length, and in good light is faintly visible to the unaided eye. It apparently does not develop so rapidly, or reach such large numbers as do some of the minuter flagellates, but because of its large size, a slight increase in numbers above the normal produces its characteristic results. The results of its over-multiplication are a cloudy, or milky appearance of the water, and a salt marsh odor, and fishy flavor.

The method now in use for the elmination of water polluting protozoa is the copper sulphate method. This consists in filling a coarse bag with copper sulphate crystals (the ordinary blue vitriol crystal of commerce being usually employed), and towing this in the water behind the stern of a boat back and forth across the reservoir until the chemical is dissolved. Most of the troublesome smaller flagellates succumb to even a slight trace of copper sulfate in the water. Thus *Uroglena* is killed by four-tenths of a pound of crystals in a million gallons of water, and a still less quantity (three-tenths per million) suffices to kill *Synura* and *Cryptomonas*. Probably most of the smaller protozoan forms, that is, roughly, those less than 65 or 70 micra in length, are killed by half a pound of copper sulfate per million gallons of water.

The natural checks upon the undue increase of any species of protozoa, are usually other larger species which devour them. In this fact may lie the solution of the protozoan pollution problem. Among the ciliates are many forms which are notably carnivorous, such as *Didinium* (Fig. 12), and various species of *Dileptus*, of which the largest is *Dileptus gigas* (Fig. 13). The carnivorous ciliates are able to make their way with great rapidity (for protozoans!) through the water, sweeping into their wide buccal, or mouth, cavities, immense numbers of smaller, less active forms. A dozen *Dileptus gigas* introduced into a quart of water containing hosts of *Synura* will, in the course of a day's time, almost completely clear the water of these forms. It has been found that cultures containing myriads of *Dileptus*, *Didinium*, and other large carninvorous ciliates possess but a faint odor, and almost no taste. A natural check upon the growth of noxious

protozoa, when once found and encouraged to develop, will obviate the necessity of killing the organisms by artificial means, and of calling into requisition special treatments to destroy the odors and tastes of the disintegrating animals. It is believed that the further study of the part which the carnivorous ciliate forms play in the reduction in numbers of the smaller protozoa, will prove to be profitable from the standpoint of reservoir water purification.

Two Great Organs

(*Continued from page 428*)

conical portion of the pipe, this portion being known as the foot. The bulk of the pipe is above. The column of air whose vibration produces the sound and whose effective length determines the pitch is measured from the plate ED up to the top of the tube if the tube is open at the top, but up to the top and back to ED if the top is closed. ED represents a plate or diaphragm which extends nearly across the pipe. The air rushing out between D and B strikes against the upper edge C of the slit represented by the opening between C and B. The result is that the air above ED is put into vibration. The law governing such pipes is that halving the effective length raises the pitch exactly one octave. Naturally, this means also that doubling the effective length lowers the pitch one octave. A very low note on the great Philadelphia organ is produced by pipes 32 feet long. One of these belongs to the open Diapason register. If this pipe were halved, the octave above would be produced; if halved again, the next octave above, and so on, by halving the effective length, the successive octaves are produced.

The reed pipe is a different affair. There is a pipe and a reed inside it. This reed may itself be in pipe form; that is, it may consist of a metal tube whose front has been more or less cut away and of a tongue of metal secured at one end and adapted to vibrate in or against the metal of the tube. A common mouth-organ—the harmonica—contains metal tongues of the same general character. The enveloping pipe—the reed pipe proper—may be of metal or of wood. If the tongue does not strike the reed but only the air, it is called a free reed.

A stop is a series of pipes whose quality is alike. There may be many or there may be few. Quality of tone is, from a scientific point of view, dependent upon the number, distribution and relative intensities of the overtones. This seems to be an assured result that will not need modification by further investigation. Assuming it to be absolutely true and adequate, one learns that the notes of any instrument whatever may be successfully imitated, provided we can arrange to have just the right set of overtones, whether the whole combination is got from a single instrument or not. It is generally easier, however, to provide for the proper overtones by the material used in making the sound, its shape and dimensions. There is probably no equal to the possible variations of the quality of organ pipes, since we are free to select the materials, etc. There is thus a continual opportunity for invention. Here we have quality in respect to its possibilities from the standpoint of the organ builder. The organist also has opportunity for developing new and pleasing qualities by combining stops.

A group of stops constitutes one of the subordinate organs into which great instruments like this Philadelphia affair may be divided. In general, each manual controls an organ. But in such cases as that of this giant instrument, where there are eight separate organs, one or more of the manuals may control two organs. Thus, at Philadelphia, the great and the chorus organs are played from one manual. The top bank of keys operates the choir organ; the next bank lower, the great organ; the third, the swell organ; the fourth, the solo organ; and the fifth, or

bottom bank, the echo organ. The second bank of keys, as already said in effect, operates also the chorus organ; the solo manual and also the echo manual may either be used to play the ethereal organ.

Each manual begins, on the left, with C (natural). Similarly, the pedal key-board starts with C. These initial C's correspond to a note two octaves below middle C of the ordinary piano. However, the pipes of a stop may not correspond to the pitch indicated by the keys and pedals. For example, the lowest note in the pedal key-board is C two octaves below standard middle C. But the big 32-foot pipes which may be brought into action after drawing the right stop lever or rod, give the C which is four octaves below middle C of the piano. Similarly, there are stops which when played yield notes an octave higher than what the keyboard indicates. All this is really simplification, as the simple drawing of a stop lever gives octaves above or below as desired. It would be an unnecessary complication to provide, for example, an extra pedal board for the set of heavy base notes beginning with the 32-foot C.

It will be seen from the foregoing, perhaps, that all boards, whether of manual keys or pedals, are standardized to begin with the G which is two octaves higher than the 32-foot C. This means then that all these boards are standardized to begin with an 8-foot C, 8 being the result of dividing 32 twice by 2. There are five full octaves plus one key to each manual. That is, they all begin and end on C natural. As each octave contains 7 white and 5 black keys, the several manuals will each have 61 keys. The pedal board contains about two and one-half octaves, beginning with C natural and ending with G natural. As the highest standard note on the manual boards is five octaves higher than an 8-foot C, the effective pipe length for a mouth pipe may be expected to be found by dividing 8 feet five times by 2. We should then get 3 inches. The smallest length of pipe in the Philadelphia organ is said to be $\frac{3}{4}$-inch. Apparently, its pitch is just two octaves above the standard final C on the manuals.

In this great organ, 179 of the speaking stops are understood to be composed of mouth pipes and 53 of reed pipes.

The names of stops refer in general to the quality of the tone and not to the pitch. The *open diapason* is perhaps the stop which may be regarded most characteristic of the pipe organ. The *dulciana* is, or may be, a stop composed of mouth pipes of small diameter, yielding a sweet tone. Reed stops may have such names as *clavion*, *bassoon*, *oboe*, etc. These are supposed to indicate that the quality of tone is the same as or similar to that of the corresponding musical instrument. The *vox humana* is a reed stop supposed to resemble in quality the human voice, as the Latin suggests.

In Denver is a great instrument which is understood to have cost upwards of $80,000. There are four manuals and 229 stop keys. The largest pipe has an effective length of 32 feet and belongs naturally to the pedal register. It is 40 inches square at the big end and tapers to 6 inches at the other end. It is made of pine and weighs 1,250 pounds. The effective length of the smallest pipe is $\frac{3}{4}$-inch. As $\frac{3}{4}$-inch is obtainable by dividing 32 feet by 2^9, we conclude that the two musical notes produced are 9 octaves apart. The little pipe is of metal, has the diameter of a straw and weighs half an ounce.

In addition to the notes properly belonging to a pipe organ, the Denver instrument possesses apparatus capable of producing such percussive effects as are suggested by such names as harps, chimes, xylophones, Glockenspiels, vibrating bells, sleigh bells, drums.

There is an automatic organ player which may be used upon occasion when a skilled organist is not available. This player may be operated in connection with paper music rolls as with the ordinary automatic piano players. A second roll provides for the orchestration of the various stops.

A special feature of this magnificent instrument consists of the *vox humana* pipes in the echo organ. A *vox humana* stop of single pipes is no novelty; but at Denver, it is possible to go beyond the solo voice and give a full quartet of voices. This is claimed as a unique feature.

Trailers in Texas Oil Fields and Washington Forests

(Continued from page 430)

wholesale grocers and the great metropolitan milk companies are also standardizing their hauling with short-wheelbase motor trucks and semi-trailers. Some of the large industrial plants which have widely separated departments inside the same factory yard are using trucks and tractors for hauling from one department to another.

In the lumber business, both in hauling from the woods to the mill and from the lumber yard to the building job, the number of trailers in use constantly increases. This was one of the first fields to take up the trailer hauling principle and it promises to be the first that is completely equipped with trailers. Illustrations show the use of truck and trailer combinations in handling both rough and finished lumber. The logging outfit shown is operated in South Prairie, Washington, and has done very good work. The length of the haul, at present, is about two miles, of which some two thousand feet is planked. The steepest grade is 15 per cent and the average grade for the hill, which is one and one-half miles long, is 9 per cent. Loads are hauled down hill. Except for shortage of railroad cars, this truck has not lost a single day since it started to work. As high as twelve trips per day have been made, but the average will be about eight or nine.

A Molding Machine Which Throws the Sand

IT will be possible before long to pour a casting without the use of a mold, so rapid are present advances. We have molding machines which are the work of several molders and now we have a sand throwing machine for filling molds. The experienced molder knows the effect and the practical value of throwing the sand in place, a handful at a time. So thrown, the sand needs no further ramming. A machine to do this more expeditiously and with equal precision has been designed, and, after passing the test of several months' experience in some of the Chicago foundries, has been put on the market.

The sand is thrown into the mold with considerable force by mechanical means. Hence a large quantity can be handled in a unit of time, so that finished molds should be turned out quickly. Obviously the density of the ramming can be regulated by controlling the speed of the impeller. The essential element of the machine is the throwing head, which is mounted on a double-jointed arm, allowing it to be swung into any required position over the mold. This head is connected by a shaft to an electric motor which runs at a high speed. It is cast with three arms, on one side of which is a pair of brackets, to which the impeller is bolted.

When in use, the whole of the head is enclosed in a combination cast-iron and sheet-iron hood. The sand, entering from a chute at the top, is violently ejected by the rapidly revolving impeller through a hole in the underside of the hood. For ordinary gray iron, a suitable speed is from 1,200 to 1,400 revolutions a minute; for steel castings a higher speed is required. The sand may be rammed at varying densities over the different parts of the pattern by passing the head slowly or quickly over the parts. Two standard types, one a tractor, the other stationary, are constructed.